The New England
Journal of Medicine

VOLUME 213 SEPTEMBER 12, 1935 NUMBER 11

The Massachusetts Medical Society

SECTION OF RADIOLOGY AND PHYSIOTHERAPY

Ball Room Assembly, Hotel Statler, Boston, Monday, June 3, 1935, 2:30 P.M.

PRESIDING:
Franklin P. Lowry, Newton, Chairman.
Philip H. Cook, Worcester, Secretary.

CHAIRMAN LOWRY: The Section will please come to order. Is there any business to be transacted at this time?

Your committee has worked for nearly a year on subjects that we thought would be interesting for both the roentgenologists and the physical therapists. We have three interesting papers this afternoon.

We are sorry that Dr. Vogt, about a week ago, was called to his home in Iowa because of sickness of his mother, and has been unable to return. Dr. Green could not conduct the discussion because it was necessary that Dr. Vogt start the papers with x-ray slides which Dr. Green was to discuss later. With your consent I am going to ask the secretary to write Dr. Vogt and Dr. Green telling them of our sorrow in the sickness of his family and that we are much disappointed in not hearing the papers. Does that meet with your approval?

(The meeting so indicated.)

CHAIRMAN LOWRY: In the field of physical therapy there are a great many new types of apparatus being brought out almost continuously. The Council on Physical Therapy has tried to select the good ones and to eliminate the bad ones, and in some instances has been successful. One of these pieces of apparatus which is before the general practitioner at the present time is the so-called "short wave high-frequency machine", or "short wave diatherm" or "radiotherm". In order that we may find out more about it, and use it more intelligently, we have asked a physicist to come and tell us what is inside, and a clinician to tell us what happens outside the box as we use this particular machine.

We are very fortunate in having Dr. Chaffee, professor of physics at Harvard University, who has gladly consented to speak to us on the physics of high-frequency machines. His particular subject is "The Physics of the High-Frequency Currents as Used in Medicine"—and there are three of them—"Diatherm, Radiotherm, and the Electric Knife". Dr. Chaffee!

THE PHYSICS OF HIGH FREQUENCY CURRENTS AS USED IN MEDICINE—DIATHERMY, RADIOTHERMY, AND THE ELECTRIC KNIFE*

BY E. L. CHAFFEE, PH.D.†

THE modern medical man makes use of a great many agencies and devices which have come directly from the physicist's laboratory. Such agencies as x-rays, radium, ultraviolet light, and devices such as the electrocardiograph, have been invaluable in the medical world. An understanding of the scientific principles underlying these physical agencies is highly desirable as a guide in the medical applications, as a guard against wrong and dangerous usages, and as a defense against extravagant and unwarranted claims. Often reticence in accepting new and useful devices is fostered by ignorance, while on the other hand ignorance often leads to abuse and tragic misuse of valuable agencies.

During the last few years there has been a rapidly increasing use of high-frequency currents of electricity in diathermy and in surgical cutting. One hears of short waves, of damped and undamped waves, of conduction and capacity currents, and a host of other scientific terms. The object of this talk is to explain the meaning of some of these terms and briefly to explain how the currents are generated and applied.

First, why are high-frequency currents used in preference to low-frequency currents? When a current which alternates in direction a small number of times per second, say sixty or one hundred times per second, is passed through living tissue, the electrolytic ions move to and fro with the alternations. As a consequence, polarization of the cells, electrolysis, nerve stimulation and muscular contraction take place, and a very small amount of heat is produced. If the frequency is increased into the tens of thousands of alternations per second, the ions have less time to move and all effects except heat rapidly disappear. With frequencies of hundreds of thousands of alternations per sec-

*Read at the Annual Meeting of the Massachusetts Medical Society, Section of Radiology and Physiotherapy, June 3, 1935.

†Chaffee, E. L.—Gordon McKay Professor of Physics and Communication Engineering, Harvard University. For record and address of author see "This Week's Issue," page 544.

ond the only effect remaining is heat and the absence of nerve stimulation and destructive electrolysis permits large currents to be passed without harm through the body with the consequent increase in the heating effect.

I feel quite sure of my position in stating that no specific effect of any particular frequency has been proved to exist, nor is there any reason to expect any specific effect because the highest frequencies used are far too low to elicit any specific molecular activities. If this statement stands the test of time, the only effect used in diathermy is the heating effect.

The rate of production of heat at any point in the body depends upon the square of the current density and the specific resistance of the tissue. The so-called "skin effect", which means the tendency of a high-frequency current to travel mostly in the surface of a conductor, is negligible when the body is the conductor. It is fairly well established, however, that the surface of the body is more intensely heated than the interior, but this uneven heating can only be due to the greater resistance of the subcutaneous tissue and to the higher current density at the electrodes, especially when small electrodes are used. The circulation of the blood is a powerful agency toward equalizing the temperature throughout the body.

Some diathermy machines generate currents of the order of a million alternations per second, while the so-called "short wave" machines apply currents having frequencies from about ten to one hundred million alternations per second. The term radiothermy has been suggested to imply the use of very high-frequency currents. All machines produce heat in the body; the principal difference between the use of the high and the ultra-high-frequency machine lies in the mode of causing the currents to pass through the body. This will be explained later.

What is the difference between damped and undamped currents and how are these two types of currents generated? Everyone who has taken a course in elementary physics is taught that when a condenser or Leyden jar discharges through a spark gap and a few turns of wire, the current surges back and forth like the oscillations of a pendulum which has been pulled aside and released. The oscillations die down; that is, they are damped. The condenser may be repeatedly charged and allowed to discharge, producing a series of damped trains of oscillations. This was the method of generating the oscillations used in early radio telegraphy, and it was natural that the same artifice should be used in the first "spark gap" diathermy machines. The currents produced by these machines consist of separated groups of oscillations, each group consisting of from ten to one hundred oscillations of diminishing amplitude. Generally there are relatively very long intervals of time between trains or groups when no current flows.

The invention of the thermionic vacuum tube provided means for exciting continuous oscillations in a circuit in much the same way as a clock mechanism maintains a pendulum in continuous oscillation by giving it a gentle push each swing. The vacuum tube rapidly supplanted the "spark gap" radio transmitter, and so the vacuum-tube diathermy machine has practically made obsolete the "spark gap" diathermy machine.

Let us contrast the two types of current. Both types of current, the damped and the undamped, produce heat, but for the same amount of heat the damped current must rise to very much higher instantaneous values because of the long pauses when no current flows. As a consequence, for the same degree of heat, the damped currents produce much higher instantaneous voltages and these higher voltages favor the production of sparks and burns. The undamped current, on the other hand, is smooth, steady and continuous, and has the minimum tendency toward sparking.

A few other points are relevant concerning the generators of damped and undamped currents. Every diathermy machine consists essentially of an oscillatory circuit comprising a condenser and an inductance, which is caused to oscillate either by repeatedly charging the condenser and allowing it to discharge through spark gaps, or by exciting the circuit by vacuum tubes. The size of the condenser and inductance determines the frequency. Power is drawn off from this storage circuit by various means, either by capacitive or inductive connection. The spark gaps are troublesome things requiring cleaning, and they are irregular in action and require frequent adjustment. On the other hand, the vacuum-tube generator works with the steadiness and regularity of a good watch and the currents it generates are steady and easily adjusted and controlled. The early "spark gap" radio transmitters caused a great deal of interference in radio reception and are hence not tolerated today except for sending SOS signals. So, too, the spark-gap diathermy machine produces a great deal of radio interference, and is hence a nuisance to radio enthusiasts.

There are several ways of causing the high frequency currents to pass through the patient. At the lower frequencies of a million cycles, the most effective way of applying the heating currents is by direct connection of the patient to the machine. Moistened pads or metallic electrodes are fixed to two places on the patient's body and these electrodes are connected by wires to the machine. The high-frequency currents pass through the patient as a part of an electric circuit. Because the current is con-

ducted to the patient by wires, the current is often called a *conduction current.*

When the frequency is very high, currents can be caused to surge in the body without actual contact. To explain this, imagine a conducting body situated between two metal plates and separated from them by air spaces. If the plates are charged, one positively and the other negatively, induced charges appear on the surfaces of the body opposite the two plates. These induced charges arise from a momentary flow of electricity within the body. If now, the charges on the plates are reversed, the induced charges on the body reverse and this reversal is brought about by another surge of electricity through the body in the opposite direction. If the plates are alternately charged first one way and then the other, electricity surges back and forth in the body to supply the induced charges on the surface of the body. The greater the number of reversals per second the greater the number of surges of electricity through the interior of the body and the greater the rate of production of heat. It is evident that currents in the body produced in this way increase with the frequency and only at the frequencies of from ten to one hundred million alternations per second are these currents sufficiently intense to produce a practical amount of heat. The currents which surge to the plates from the machine and those which surge in the body are sometimes called *capacity currents,* but it is to be emphasized that capacity and conduction currents are qualitatively identical.

There are undoubtedly certain advantages in the capacity method of connection between the patient and the machine. The metallic electrodes are generally imbedded in rubber or some other insulating substance so that there is no direct connection from the machine to the patient. This considerably diminishes the danger of any low frequency currents passing through the body incident to any accidental breakdown in the machine. Furthermore, the insulation diminishes the danger from burns due to sparks and arcs.

A third method of applying high-frequency currents is that suggested by Dr. W. R. Whitney of the General Electric Company. A heavily insulated wire carrying high-frequency currents is wound several times around the portion of the body to be heated. Currents are induced in the tissues through the action of the magnetic field instead of through the electrostatic effect. The induced currents circulate in paths which follow more or less closely the contours of the coil, and heat is conveyed into deeper regions by conduction and by the blood. Here again, the body is not in direct contact with the machine and danger from burns due to arcs and sparks is considerably diminished.

Claims have been made that differential heating can be obtained, especially at ultra-high frequencies, so that one organ or part can be heated to a greater degree than the surroundings. Some of these claims are based on measurements of temperature obtained by inserting thermocouples into various parts. One should look with suspicion upon any temperature measurements made with thermocouples or with any temperature measuring device which is a conductor of electricity, because such thermometers are heated by high frequency currents produced in them during the operation of the machine. Furthermore, the distribution of current in the tissue may be changed by their presence.

McLennan and Burton* have shown experimentally and mathematically that corresponding to each frequency there is a particular specific resistance of the tissue which evokes the greatest heat production. It should be noted, however, that this does not mean that corresponding to each specific resistance there is a frequency which evokes the greatest heating. With this scientific fact before us, it is impossible to say that differential heating is impossible, although considering the temperature equalizing effect of heat conductivity and blood flow, it seems very doubtful that differential heating can be accomplished and controlled to any practical extent.

The action of high-frequency currents in surgical cutting and in coagulation, desiccation, etc., again depends upon the heating effect of the currents. A small electrode gives a high current density at the electrode with a consequent rapid production of heat and a high temperature. If the temperature is sufficiently high, coagulation results, and if still higher, destruction and carbonization take place. If the electrode is not in close contact with the tissue an arc or spark bridges the gap and high temperatures are produced in very localized areas, and the cells are disrupted.

When the current density at the electrode is increased beyond that necessary for coagulation, cutting takes place. Usually the electrode is smaller than for coagulation, to increase the current density. It may be a needle, a wire, or a thin, narrow blade. A good incision shows very little coagulation and no carbonization, which indicates that some effect causes the cutting other than the high temperature produced by the passage of the current through the tissue. McLean† states that there is a minute arc between the electrode and the tissue when a satisfactory incision is made. This seems to be the most plausible explanation of the cutting effect. A thin film of gas or vapor between the electrode and tissue maintained in an ionized

*McLennan, J. C., and Burton, A. C.: The heating of electrolytes in high frequency fields. Canad. J. Research. **3**: 224, 1930.

†McLean, A. J.: Bovie electrosurgical current generator; some underlying principles and results. Arch. Surg. **18**: 1863, 1929. Characteristics of adequate electrosurgical current. Am. J. Surg. **18**: 417, 1932.

state by the current would account for the relatively high voltage of about 200 to 250 between the electrode and tissue for a good incision. The rapidity with which a cutting electrode advances and the absence of coagulation except in the surface of the cut, are consistent with the idea of an extremely intense and localized heat. The blade or electrode remains clean as if it never came in contact with the tissue. The film of ionized vapor probably separates the electrode from the tissue so long as it is maintained but if the power supply is too low the film is dissipated, the tissue sticks to the electrode, and cutting ceases. Damped currents have not been so satisfactory for cutting as the undamped currents and can be used only by making the number of trains of oscillations per second very large by shortening the spark gap. It is probable that periods of no current flow allow the ionization to dispel unless the inactive periods are very short, whereas the continuous undamped currents more effectively maintain the ionized film.

Barring any specific biological effects, either in diathermy or in electrosurgery, about the only factors influencing the choice of frequency are the modes of application, whether by direct contact or through capacity electrodes. The ultra-high frequencies are less satisfactory for electrosurgery because of the large currents which pass through small capacitances, such as that formed by the surgeon's hand grasping the insulated cutting electrode. The ultra-high and high frequencies are advantageous in diathermy where application through capacity electrodes is preferable. The increasing number of uses of this new agency has considerable influence in determining the choice of frequency, and it is probably best to leave this point open for the physician and for future developments to decide.

DISCUSSION

CHAIRMAN LOWRY: There is a doctor in New York who is giving a good deal of his time to research, who has done much to rationalize physical therapy. That is Dr. Bierman, and it gives me great pleasure to welcome him here as a fellow member of the Academy of Physical Medicine, to speak to us this afternoon. Dr. William Bierman of New York City.

DR. WILLIAM BIERMAN: *Mr. Chairman, and Members of the Massachusetts Medical Society and Guests*—Permit me first to make some little changes in the title of the paper as it has been assigned to me. I shall not discuss the subject of fever or temperature elevation of the entire body as created by the short wave current or by any other mechanism. I shall limit myself to the question of the therapeutic use of short wave currents and I want to take the liberty of doing that, because I realize that at the moment there is a very strong controversy as to the relative merits of the short wave current and the other method of conversive heating which we have used for a period of years, diathermy.

Now, as to the term "short wave radiation", the word "radiation", as Professor Chaffee has told you, is a misnomer. We are not dealing with radiation frequencies, thinking of the word as we apply it to x-rays, or to radium, or radiations from luminous or ultraviolet sources. We are dealing with actual current flow, and so the use of the word "radiation" should be deleted from the title. I have done so on the title of the paper which I have with me here this afternoon.

That leaves us just two other words, "short wave". We feel with Professor Chaffee that the terminology is very labored, and inadequate. In defining the method which we use, we should possibly refer to the frequency of the current. I have thought that we might refer to the application in megacycles, because it makes it a bit more awkward to say "one hundred million cycles". It is much easier to refer to the terminology of the physicist or engineer, and refer to the subject in megacycles. It may well be that our clinical evaluations of the results through the years and in different parts of this country and abroad, would be much better if we had definite knowledge of the exact frequencies used by one man in contrasting his results with the frequency of the currents used by another man.

I think now that we have torn the title to pieces, and agreed not to use any part of it, except as to present usage, the title of the paper before me is "The Therapeutic Use of Short Wave Currents." My paper is a relatively long one, because I have asked the physicist with whom I work, Mr. Schwarzschild of the Beth Israel Hospital, to write that part which deals with the physics. I knew Professor Chaffee would discuss that subject with you, but I as a physician know that it becomes very difficult for a physician to deal with the subject of the physicists, conductive currents, capacity currents, or as we have referred to it here, the displacement currents. Just what is the difference? I can attempt to explain it to you, but in the presence of an authority far greater than I, I would defer the matter to Professor Chaffee, and so you are saved from my perusal of the first eight pages of my discussion, although I feel justified in including them in the paper as it may be printed, so that those of you who may desire may read our explanation of the difference between the currents produced by machines whose frequencies are much smaller than those produced by so-called short wave apparatus. I will encroach somewhat on Professor Chaffee's field, and show determinations we have made from studies of the phantom, studies made on animal tissue, both dead and living, to give you some little understanding of the somewhat different action of the heating of currents of relatively low and relatively high frequencies, and if we can have our first slide we will begin.

(Dr. Bierman then read the paper on "The Therapeutic Use of Short Wave Currents", illustrating his discussion with lantern slides.)

THE THERAPEUTIC USE OF SHORT WAVE CURRENTS*

BY WILLIAM BIERMAN, M.D.,† AND MYRON SCHWARZSCHILD, M.A.†

ONE of the most important properties of the electric current is its ability to heat substances through which it passes. This property cannot be used indiscriminately for heating human tissue because, unfortunately, there are basically chemical effects accompanying the passage of this current through tissue. In order to avoid these chemical effects, it is necessary to use electric currents the direction of which changes rapidly, the so-called alternating currents. There are two important ways of specifying the number of alternations a second: the first, and the simplest, is merely to specify that number. This is done in ordinary technical applications of electricity where we speak of sixty cycle current, for example, meaning that the number of alternations a second is sixty. Where the number of alternations is very high, in order to avoid the use of very high numbers it has been customary to refer to a quantity known as the *wave length*. The vibrations of the electric current travel with the speed of light, three hundred million meters a second, so that if the frequency of alternations is one million, for example, the wave length (that is, the distance between successive peaks of current) would be three hundred million divided by one million, or 300 meters. This is in the range of frequency of ordinary diathermy. A short wave apparatus which produces a wave length of ten meters is producing an electric current whose frequency of alternation is three hundred million divided by ten, or thirty million alternations a second.

All heating by electric currents is basically of the same nature. At any point in a substance, the heat generated depends upon the electric field strength at that point and the conductive current at that point and, in fact, it is proportional to the product of these two quantities, and aside from magnetic effects involves no others. The problem of determining the distribution of heat in a mass of tissue when it is subjected to the action of diathermy or of short wave resolves itself, then, into the problem of determining the electric field strength and the conductive current density at every point in the mass.

These two quantities vary in magnitude from point to point in the medium, and their distribution depends upon the geometric arrangement of the electrodes, the size and shape of the medium, and the distribution of electric constants in the different parts of the medium.

It is necessary at this point to distinguish between *conductive* current and *total* current. In a varying electric field such as is produced either with a diathermy machine or a short wave machine, where the field changes its direction many times a second, the current at any point does not necessarily follow the electric field, that is to say, when the electric field is a maximum in one direction, the current may not be at its maximum value in that direction, and when the field intensity is reduced to zero preparatory to going in the opposite direction, the electric current may not simultaneously be zero, but may have some value in one or the other direction. In such a case, we speak of a difference in phase between the current and the field strength, or voltage. While both are varying in a sinusoidal manner, there is a time difference between the attainment of maximum value, the current attaining its maximum value earlier or later than the field intensity. A current varying in this manner *out of phase* with the field intensity which produces it may be considered as made up to two components: one a so-called *displacement* current, which is completely out of phase with the field intensity, that is to say, it attains its maximum at the instant when the field intensity is zero and runs through the zero point at an instant when the field intensity is a maximum. The other component we have called the *conductive* current. It is entirely *in phase* with the field intensity, attaining its maximum at the same instant as the field intensity maximum and passing through its zero value at the same instant as the field intensity passes through its zero value. The actual current at any point is, of course, the total, that is, the sum of these two currents, and its phase is shifted with respect to field intensity, but for the purpose of studying the power dissipation, that is, the conversion of electric energy into heat, it is necessary to separate the current into these two components, displacement and conductive currents; and the heat at any point is independent of the displacement current but is proportional to the product of the conductive current and the field intensity.

The value of the conductive current and the field intensity at any point in the medium, of course, depends not only upon the electric constants of the point in question, but also upon the electric constants of other parts of the media. The study of the interaction of one part of a medium upon another is the most difficult part of the problem.

In diathermy, where the frequency of alternations is relatively low as compared with the

*From the Department of Physical Therapy, Beth Israel Hospital, New York City.
Read at the Annual Meeting of the Massachusetts Medical Society, Section of Radiology and Physiotherapy, June 3, 1935.

†Bierman, William—Attending Physical Therapist, Mt. Sinai Hospital, New York. Schwarzschild, Myron—Physicist, Beth Israel Hospital, New York. For records and addresses of authors see "This Week's Issue," page 544.

short wave, we may for practical purposes assume that the current at any point is wholly conductive. Under these conditions, the current distributed through the medium and the distribution of electric field through the medium depends upon a well-known constant of matter, *conductivity*. Such a simple idea as the current takes the path of least resistance is here applicable and we can predict with some assurance the direction and magnitude of the current at various points by making use of this simple concept. Since the current here is entirely conductive, that is, completely in phase with the electric field, we may conclude that the heat developed at any point, being proportional to the current times the field intensity, is in fact proportional to the square of the current, and the proportionality factor involves only the conductivity.

When the frequency is increased and we come into the range of tens of millions of alternations a second, the problem becomes considerably more involved. Here we can no longer neglect the displacement current, that is, the component of the current which is out of phase with the electric field. At infinitely high frequencies the current is all displacement current and no heat can be developed. At intermediate frequencies, that is in the range of so-called short waves, we must endeavor to determine the distribution of conductive currents and of field strengths. To form any conception of the distribution of conductive current it becomes necessary to determine the distribution of total current, that is, to determine the displacement current as well. The displacement current depends for its distribution upon the electric characteristics of the medium known as the dielectric constant. The dielectric constant has a meaning for the displacement current essentially similar to the meaning of conductivity for the conductive current. The conductivity is a measure of the conductive current which would be produced in a substance by a unit of electric field strength. The dielectric constant is, in a similar way, a measure of the displacement current which would be produced in a medium by a unit of field strength. Here again we must remember that the dielectric constant at a single point is not sufficient to tell us the displacement current, but account must be taken of the interaction of other parts of the medium. This point is the stumbling block for any simple explanation of the distribution of heat.

The interaction of other parts of the medium upon the point in question is a matter fraught with great mathematical difficulty and has only been completely solved in very simple cases. Certain simple types of distributions will be considered for the purpose of showing how this interaction functions and wherein the difference lies between the low frequency diathermy and the high frequency short waves.

Suppose we have a pair of electrodes placed on either side of a mass of fatty tissue and we arrange matters so that a certain fixed total current flows through the circuit. Fatty tissue has a low conductivity but a reasonably high dielectric constant. If the frequency is very low, all current measured by the meter is conductive current and since the conductivity of the material is low, the electric field strength necessary to drive this current through the material must be very high. Hence the product of electric field strength and current is high. Now if the frequency is increased, keeping the current the same, some of the current no longer remains conductive but becomes displacement current, so that for the same total current only a portion of it is in phase with the electric field produced. Since the conductive current and the field intensity are proportional, the decrease in conductive current must be accompanied by a decrease in field intensity. Hence both factors, the electric field strength and the conductive current, are lower than they were in the low frequency case so that the total heat developed is reduced. It follows thus as a result of this consideration that per unit of current, the lower frequency is more effective in heating than the high frequency.

It is of course not to be concluded that the high frequency cannot be used to produce heat in such material because it is easily possible to raise the current to a point where in the high frequency case the same amount of heat would be developed as in the low frequency case. But for current of the same magnitude, the low frequency is the more efficient heating arrangement.

Now suppose that between these two plates instead of a mass of fatty tissue we have two layers, one of fatty and one of vascular material. In the fatty substance the dielectric constant is somewhat lower than that in the vascular tissue, while the conductivity of the vascular tissue is much higher than the conductivity of the fatty tissue. Let us repeat our imaginary experiment and pass a current of definite magnitude between these plates. At low frequency the dielectric constant plays no rôle because there is no displacement current and the field intensity in the low conductivity fat must be much higher than the field intensity in the high conductivity vascular tissue. Since the current is the same in both and is all conductive, the fatty tissue becomes hotter than the vascular tissue. Now if the frequency is increased to a sufficiently high value so that a considerable part of the current is displacement current, the heat distribution changes completely. In the fatty layer with its low conductivity, practically all the current may be displacement current while in the vascular tissue, since

the conductivity is high, a considerable portion of the current remains as conductive current. The total current is the same in both parts but now the conductive current which is the important one for the calculation of heat conversion is higher in the vascular tissue than it is in the fatty tissue. The field strengths in the two types of tissue, of course, will depend upon the conductive current, and since this is now higher in the vascular tissue than in the fatty tissue, the heat generated will be higher in the vascular tissue. By a suitable selection of frequency it is possible to attain a frequency at which the heating is the same in both. This will be the frequency at which the field strength in the fatty tissue is greater than in the vascular tissue by the same proportion as the conductive current is greater in the vascular tissue than in the fatty tissue. If the frequency is raised beyond this point, the vascular tissue becomes hotter than the fatty tissue. So in a relatively simple example it is possible by proper selection of frequency to heat one type of tissue at the expense of the other, or to heat both uniformly.

Let us consider another example. Now the electrodes are not placed in contact but are held at some distance away in the air from the mass of tissue. At low frequencies where there is no displacement current, it is impossible to produce any heat in the tissue since the conductivity of air is zero. At high frequencies, however, in spite of the zero conductivity of air, it is perfectly possible to heat the tissue because, while there is no conductive current in the air, conductivity being zero, there does exist a displacement current since air has a dielectric constant different from zero. All substances permit the passage of current at high frequencies; if not the conductive, then the displacement current. Parenthetically we must say that these considerations apply only to conditions in which the magnetic field accompanying the current is to be neglected. This is true of all plate type applications at any practical frequency.

When we come to consider more complicated distribution of different types of tissues than the simple cases here discussed, matters become extremely involved and general statements are in order. As a general rule with the short wave and high frequencies, we are in a position to obtain more uniform heating of different types of tissue than with the low frequency. There are certain cases in which this is not true. For example, if we had two materials of the same conductivity but of different dielectric constants, the low frequency diathermy would heat them uniformly because it recognizes no effect of the dielectric constant, whereas the high frequency current would heat them differently. With the exception of fat, however, all human tissue has practically the same dielectric constant so that this consideration need not trouble us unduly. While this tendency to more uniform heating for higher frequencies is certainly present, it is nevertheless possible by the proper selection of frequency to heat a certain type of tissue more than others. This is what is commonly known as *selective heating.* For example, with a frequency of about thirty million, a maximum heating is produced in tissue of conductivity in the range of lung tissue, while with a frequency of seventy-five million, the maximum heating occurs in cartilaginous tissue. While these maxima exist, it nevertheless is true that as a general rule, these maxima are not very sharp and short waves tend to produce a more uniform distribution of heat than long waves.

One factor in the problem has purposely been left out of consideration up to this point, that is, the question of the effect of size, shape and position of electrodes. The problem of heating of different types of tissue which we have discussed up to this point is sufficiently complicated in itself without at the same time attempting to take into account these geometric factors. They can be considered best by themselves, that is, we determine what the geometry of the situation can tell us with regard to heating of a homogenous mass of tissue and then make use of our knowledge of differential heating as best we can in connection with any particular case. The geometric angle of the problem is best considered in a manner somewhat similar to that to which we have been accustomed in diathermy. We determine, if possible, the lines of flow in the substance to be heated, considering it as homogenous. We can then make any corrections we desire on the basis of the inhomogeneities existing. Since the heating in the high frequency field is much more uniform than in diathermy, the amount of such corrections will usually be considerably less.

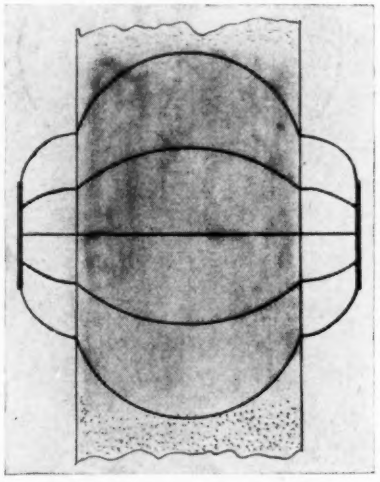

FIGURE 1. Showing the lines of electric induction in the case of a large homogenous body exposed to the short wave field.

There has been a tendency in the past in con-

sidering diathermy to imagine the lines of current flow to run directly from one electrode to the other. This is, of course, far from the truth. The field establishes itself accompanied by a spread through a large part of the medium subjected to the action of the current. In most cases with diathermy, the concentration of current is greatest at the electrode and diminishes in value as one enters the tissue. There is a tendency for more heat to be developed in the region between two electrodes placed close together, but if the electrodes are any distance apart, the heat developed near them represents practically all of the energy and the heat developed in the rest of the body is very diffuse. If the body to be heated were small compared with the electrodes and the electrodes were so arranged that the current must flow through the body to be heated, this heat developed would be uniform and would occupy the entire space. Similar considerations apply in short wave.

Figure 1 shows the lines of electric induction

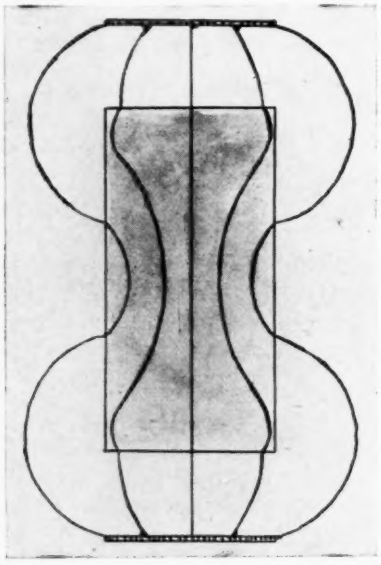

FIGURE 2. Showing the lines of electric induction in the case of a small homogenous body exposed to the short wave field.

in the case of a large homogenous body exposed to the field between two plates properly spaced. The lines of flow and the heating in this case are essentially the same as that which would be obtained with diathermy, with contact plates of somewhat larger size than the plates used in short wave. The other case of the small body is shown in figure 2. Here the lines of induction tend to pull in and fill the body so that the heat is essentially uniform with possibly somewhat greater heating at the center. Such an effect can be produced with diathermy by using cuff electrodes. The field would then be very similar and the heating have essentially the same distribution.

With a homogenous body, then, it appears to be possible to duplicate with diathermy the distribution which would be obtained with short wave and the principal virtues of short wave lie in the ease of application since a direct contact is not required, and in the more homogenous heating of the elements of a heterogenous body.

The figure shows the heat produced by diathermy and short wave in a bovine thigh. The electrodes in each case were placed in the position

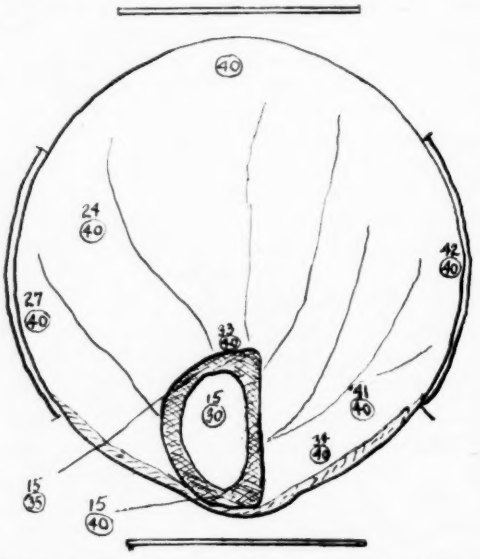

FIGURE 3. Showing the heating of a bovine thigh in the diathermy and short wave fields. Temperatures in degrees centigrade. Short wave determinations indicated in circles.

indicated for most uniform heat, the diathermy plate over essentially exposed muscle and the short wave plates across the bone. In the diathermy case, the temperature distribution was far from uniform. Near one electrode the temperature rose very much more than near the other because of a thick layer of fascia. The bone and marrow heated not at all. The temperature in fascia layers between the muscle was higher than the temperature in neighboring muscle tissues. The reason for these differences lies, of course, in the differences in conductivity between fascia, muscle and bone. With short wave, on the other hand, the heat of the muscle and fascia was essentially the same. The temperature of the bone was also raised to practically the same level, while the marrow remained relatively cooler. The entire impression is certainly that of much more uniform heat. The layer of fat surrounding one-half of the section was not heated unduly in the short wave field, whereas if it had been possible to pass diathermy in the same direction, this fat would have burned. (There was no skin covering this fat.)

These observations will indicate clearly that on the basis of the physical characteristics of the currents and of animal tissue, it should be possible to exert a more uniform heating effect

upon the tissue lying beneath the surface of the body by means of the short wave than by diathermy.

Living tissue differs greatly from dead tissue in that it possesses a rapidly circulating medium which can carry heat away from the region where it is produced. The most direct way of determining the actual temperature produced within tissues is to measure it by means of thermocouples. We performed such experiments on normal subjects. We applied diathermy and short wave currents to the thigh by means of cuff electrodes. We have previously

FIGURE 4. X-ray showing position of intramuscular and subcutaneous thermocouples in thigh.

described the results of temperature determinations when diathermy was applied by means of cuff electrodes to the leg[1].

We conducted two experiments on two different subjects. The intramuscular, subcutaneous and skin surface temperatures were taken before the application of the heating current. The machines were then applied for a period of twenty minutes, the current turned off, and the thermocouple needles reinserted immediately afterwards into the same area. Readings were then continued for an interval of several minutes. The subject in experiment No. 1 was bigger than the subject used in the second experiment. The thigh measurements indicate this, that of the first man being about fifty-four cm. in circumference, and that of the second about forty-four cm. in circumference.

In the first experiment, the short wave was applied in the morning. Diathermy was applied to the same thigh of the same subject in the afternoon. The intramuscular temperature before the diathermy experiment was 100°F., as contrasted with 97.7°F. before the short wave experiment. In other words, although more than two hours had elapsed between the time at which the short wave machine was shut off and the time at which the temperature determination was made prior to the diathermy application, there was still some elevation of intramuscular temperature. It is, of course, possible that this persistent local temperature elevation might have been due to the reaction to the trauma caused by the insertion of the thermocouple needle. In the first experiment, the greatest temperature rise was in the subcutaneous tissue when diathermy was applied, and next in the subcutaneous tissue when short wave was used. The intramuscular temperature rose more than five degrees F., following the application of short wave, and only about two and one-half degrees F., following the application of diathermy.

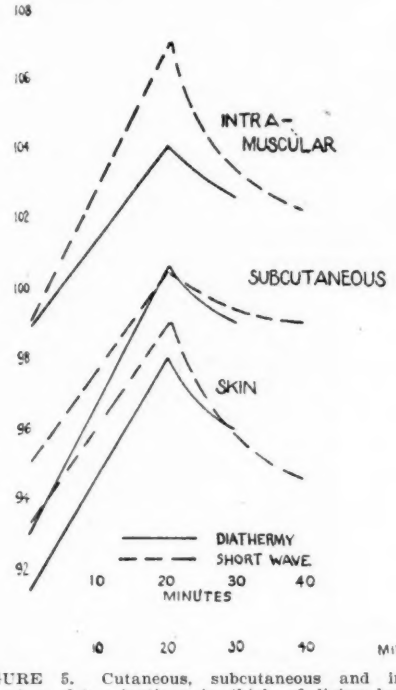

FIGURE 5. Cutaneous, subcutaneous and intramuscular temperature determinations in thigh of living human subject before and after exposure to twenty minutes of diathermy and to twenty minutes of short wave current. Cuff electrode technique. Temperatures in degrees Fahrenheit.

In the second experiment, the greatest rise (about eight degrees F.) occurred in the intramuscular temperature following the application of the short wave current. The next highest (about seven and one-half degrees F.) occurred in the subcutaneous tissue following the application of diathermy. The rise in the subcutaneous temperature after short wave amounted to about five and one-half degrees F., while the intramuscular following diathermy was only about five degrees F.

In the second experiment, the first application was that of diathermy. It was made to the left thigh. About twenty-five minutes after this ap-

plication, the short wave was applied in a similar manner to the right thigh. This experiment was a more satisfactory one because the intramuscular temperatures prior to both diathermy and short wave were almost the same.

From these experiments we can state that with the technique employed, the short wave applications can cause an elevation of intramuscular temperature as high as and higher than diathermy when applied in the same fashion. The elevations of temperature produced by diathermy in our experiments are about the same as those reported by Mortimer and Osborne[2]. The short wave temperatures are decidedly higher.

Whether there be any effect other than that of heat on applying the short wave current has not been determined with absolute definiteness, but a possibility does exist, as indicated by the work of D'Arsonval and by the work of Mellon, Szymanowski and Hicks who showed the attenuating influence upon diphtheria toxin[3]. In these experiments the heating effect of the current was carefully excluded.

There are many biologic changes which occur as a result of temperature elevation of living tissues. We have referred to some of these[4]. They include the production of an active hyperemia, with its dilatation of blood vessels, increased permeability, changes in capillary and intercellular pressure values[5], chemical changes such as those in pH, and carbon dioxide and oxygen content[6], increased phagocytosis[7], etc.

From the point of view of the practicing physician and surgeon, the most important consideration is the determination of the clinical results obtained by the use of this current. The consideration of the physical and physiological changes is important in order logically to explain the clinical changes, but, after all, the proof of the pudding is the eating thereof. Clinical impressions, in order to become definite, must be based upon observation on thousands of cases by many different men over a period of several years. Inasmuch as this therapy is relatively new, the number of cases treated has not been sufficiently large, nor the length of time sufficiently long, to permit anything aside from impressions. We have treated well over one hundred cases during the past two years. We have gained the impression that, in general, the short wave current may be used for the treatment of those conditions for which medical diathermy has shown itself to be of value. These conditions include such pathologic states as bursitis (especially about the shoulder joint), traumatic tenosynovitis, myositis, myofascitis, sprains, and arthritis. The types of arthritis treated with most satisfactory results are the traumatic and gonorrheal. The problem of infectious or rheumatoid arthritis is complex because of the focal and systemic factors. Local joint heating is one of the adjuncts in the treatment of this condition. In many of our patients the vertebral and the sacroiliac joints were involved. Our impression is that the results obtained by the use of the short wave current in the treatment of these conditions are superior to those obtained by the use of diathermy. We must not forget here as in all other conditions where heat is applied, the question of dosage should be kept in mind. We have, for example, observed aggravation of the pain about the sacroiliac joint following short wave treatment when the reaction to diathermy was decidedly less severe. The ability to create a greater amount of heat may be a disadvantage. For this and for other reasons, such as its surgical usefulness, it is reasonable to conclude that diathermy apparatus will not at the present time be replaced by machines giving short wave currents.

Our experience leads us to believe that the use of heat is of value in the treatment of paranasal sinusitis. We have seen individuals suffering from pains due to the involvement of ethmoid, sphenoid, frontal and maxillary sinuses secure rapid and marked relief following the application of diathermy applied by means of a specially constructed cast and following the use of the short wave currents. Many of these patients had for years been under treatment by nose and throat specialists of good standing and of undoubted ability. The nose and throat specialist should add this form of treatment to whatever else he believes to be of value in treating both acute and chronic sinusitis. Here, as elsewhere, the surgical principle of adequate drainage is an important one.

Many of the proponents of the short wave current in Europe have been particularly enthusiastic about its use in the treatment of infections. We have treated such diverse infections as axillary abscesses, infections of the finger, carbuncles of the neck, infected pilonidal wounds (after surgical enucleation), furuncles of the nose and face, infected cervical glands, chronic osteomyelitis (with drainage) and chronic purulent otitis media. Our impression is that the short wave current is of great value in the treatment of these conditions but must be used with surgical judgment.

It appears to be possible frequently to abort localized acute infections if they are treated in their early stages. Very often, however, if the nflammatory process goes on to suppuration, this suppuration seems to develop much more rapidly than it would without the treatment. When it does occur, it is our practice to provide drainage surgically unless such drainage takes place spontaneously. We think it wrong to treat acute suppurative processes without drainage. There is nothing new in the application of heating procedures for the treatment of local infections. Warm poultices have been used for many years. We have used the conductive, the convective and the conversive heat from radiant sources for a

long time. It is therefore not necessary to ascribe any specific effects of the short wave currents upon microörganisms to explain the beneficial influence of a procedure which creates heat in the involved area with a thoroughness greater than any other measure used thus far. It is our definite impression that when drainage does exist, the infected process usually appears to heal very much more rapidly following short wave applications than with any other forms of treatment we have used heretofore. It has generally been considered that diathermy is contraindicated in the treatment of acute local infections. It would, of course, be a matter of practical difficulty to apply diathermy electrodes over such acutely inflamed areas.

Short wave currents have the advantage of ease of application not only over areas of infection but also over other regions such as the ear, the eye, the nasal sinuses, and the lower spine.

To achieve the best results it is necessary to have some knowledge of the technique of the application of these currents. The condenser plates should be held at a distance of about one-half inch to one inch away from the area treated. Schliephake[8] insists that no material be interposed between the condenser plates and the surface of the body (aside from his glass shoes), while others feel that good results may be obtained if the condenser plates are kept away from the surface by means of felt pads or towels. It is best to remove the clothing from the part to be treated and care should be taken that there is no metal in the field.

An agency such as this which is sufficiently potent to produce considerable elevations of local tissue temperature is not devoid of the possibilities for harm. Burns can be produced if the application is made carelessly or to a region which is anesthetic so that the patient cannot experience the sensation of thermal discomfort. Such burns have been reported[9].

The enthusiastic statements which have been made concerning the therapeutic value of short wave currents have stimulated manufacturers of apparatus to place numerous machines on the market. Many of these machines are of very little, if any, value. The fact that a neon bulb may be excited when placed in the neighborhood of the condenser plate is no indication of the therapeutic value of an apparatus. The practitioner may be guided by the Council on Physical Therapy of the American Medical Association which has been investigating the value of different machines made by various manufacturers.

REFERENCES

1. Bierman, W., and Tarbell, L. A.: Temperature determinations during local application of diathermy. Arch. Phys. Therapy. **15:** 645 (Nov.) 1934.
2. Mortimer, B., and Osborne, S. L.: Tissue heating by short wave diathermy. J. A. M. A. **104:** 1413 (April 20) 1935.
3. Mellon, R. R.; Szymanowski, W. T., and Hicks, R. A.: An effect of short electric waves on diphtheria toxin independent of the heat factor. Science **72:** 174 (Aug. 15) 1930.
4. Bierman, W., and Fishberg, E. H.: Some physiologic changes during hyperpyrexia induced by physical means. J. A. M. A. **103:** 1354 (Nov. 3) 1934.
5. Landis, E. M.: Micro-injection studies of capillary blood pressure on human skin. Heart **15:** 209 (May) 1930.
6. Bazett, H. C., and Sribyatta, L.: Effect of local changes in temperature on gas tensions in tissues. Am. J. Physiol. **86:** 565 (Oct.) 1928.
7. McCutcheon, M.: The effect of temperature on the rate of locomotion of human neutrophilic leucocytes in vitro. Am. J. Physiol. **66:** 185, 1923.
8. Schliephake, E.: Short Wave Therapy. London: The Actinic Press.
9. Kling, D. H.: Burns, produced by radio short wave and ultra-short wave therapy and their prevention. J. A. M. A. **104:** 1981 (June 1) 1935.

DISCUSSION

CHAIRMAN LOWRY: Dr. Bierman has given us an excellent talk. He has a thought that I wish to pass on. He confided in me just before he came in that he takes the time and money necessary for running a home, remains a bachelor, and uses it for research. There are some young men here. Maybe you will follow his example. We need all the help in this field that we can get.

The meeting now is open for discussion of the last two papers.

DR. E. A. CODMAN, Boston: *Mr. Chairman*—I should like to ask the last speaker whether experiments have been done by putting in, through a cannula, wax that will melt at given temperatures and then dissecting the specimen after the current has been used to find whether the wax has been melted.

CHAIRMAN LOWRY: Would you like to answer that now or at the end?

DR. BIERMAN: Possibly I will answer all the questions at the end.

DR. LOUIS FELDMAN, Boston, Mass.: I have made use of the so-called "Short Wave" generator, twenty-four meter wave length type, for about seven months. First I experimented upon small animals in vitro and in vivo, followed by over 1,000 treatments on the living human body. The indications for its use were the same as for classical diathermy; that is, wherever a deeper penetration of tissue heat was required. Two-thirds the dosage formerly used in conventional diathermy was taken as the standard in the treatment of my patients. The duration was fifteen or twenty minutes, cuff method on extremities, contralateral pad method elsewhere. The dosage was also computed on the basis of square surface area of condensor electrode; always taking into consideration the individual tolerance to heat.

The most satisfactory results were obtained by the interposition of one quarter inch felting, cellulose cotton or toweling between the bare skin and the condensor surface; the pads being held in place by elastic bandages or sand bag abutments. The skin was observed at frequent intervals to see that there was no undue reddening, burning or discomfort or evidence of collection of moisture, or pools of sweat. The radiations have a tendency to concentrate in such localities, producing an increased density of current with resultant production of burns. This tendency has been minimized to a certain extent, by proper technique as above described. With ordinary care, common sense and judgment together with skill, their likelihood to occur is less than with ordinary diathermy. The cuff method on extremities showed definitely more penetration through the tissues than by use of diathermy.

In the one thousand treatments given we did not get a single burn; but, previous animal experimentation and observation on patients treated elsewhere

have shown the possibility of burn production. Treatment through street clothes is absolutely dangerous and should not be advocated.

The types of condition treated in our series were various kinds of infection, bone and joint diseases and injury. We had among them fifteen cases of prostatitis and ten cases of paranasal sinusitis, several of the latter being physicians. The clinical results to date have been very satisfactory as proved by repeated check-ups, physical examinations, laboratory tests, x-ray studies before, during and after the treatments were completed.

Dr. Bierman has been very kind to come here and give us the benefit of his extensive knowledge and original research for which the Society owes him a debt of gratitude. Therefore, Mr. Chairman, I make a motion to that effect.

DR. WILLIAM D. MCFEE, Boston: The statements of Professor Chaffee, particularly in reference to the question of difference in wave length give us a clearer understanding of this subject.

Dr. Bierman mentioned that in treating conditions such as sacroiliac disturbance with short wave he had frequently observed that there would be an increase of pain. I have observed a similar effect and it occurs to me that this may be due to the action of the short wave in bringing more blood into the area thus increasing pressure which would temporarily aggravate pain. This does much to prove Dr. Bierman's statement that the matter of dosage is an important factor and that we should be careful not to give such patients all they will tolerate of the heat effect but we should use conservative judgment and be guided by the reaction of the individual as well as the effect on the local tissue. Dr. Bierman has done much to correct many wrong ideas concerning the use of short wave and I am sure his visit to us will be greatly appreciated.

DR. JOSEPH RESNIK, Boston: I wish to ask Professor Chaffee whether the statement he made regarding spark gap and vacuum tube, that the spark gap is much more likely to produce burns than the vacuum tube, is based only on the principles of physics involved. That is to say whether it is entirely theoretical, or did reports reach him where by reason of spark gap apparatus such results have been produced? If his statement was not based on clinical experience, I would like to ask the next speaker, Dr. Bierman, to comment on this question.

DR. MCFEE: I would like to ask Dr. Bierman whether an electrode has yet been devised which can be used effectively and safely in conjunction with short wave for cavity treatment, such as might be applied in disease of the prostate gland.

DR. PAUL H. WILCOX, East Gardner: Dr. Bierman made a comparison of diathermy and radiothermy or short wave, but it was not clear to me how he standardized the question of dosage in terms of voltage or amperage, or sizes of electrodes, which in my limited knowledge seem to me important factors in making a comparison. One other question: Did you ever encounter any difficulty from overheating the metal in a person's teeth when you were dealing with conditions around the head?

CHAIRMAN LOWRY: Any further questions? Dr. Chaffee, will you answer the question, and give us any closing thought?

PROFESSOR CHAFFEE: My statement that damped waves are apt to produce more sparking is based entirely on the known physical fact, that the higher the voltage the more tendency to spark. As I explained, damped waves of necessity must, for the same amount of heating rise to much greater instantaneous values, and hence on this account the higher voltage tends to increase the amount of sparking.

I would like to ask Dr. Bierman whether he used mercury thermometers or thermometers containing some other liquid. I have always wondered why one would not use alcohol thermometers.

It is barely possible that in using a mercury thermometer electric currents might surge in it producing heat thereby giving an erroneous reading. I don't say that took place, and I think Dr. Bierman's procedure probably as good as could be had, excepting possibly for the use of mercury thermometers.

DR. BIERMAN: I will answer Professor Chaffee's question first. We used both alcohol and mercury thermometers, and found we did not get any different readings. My physicist scared me away from mercury thermometers for five years, because he told me we would get unsatisfactory results. After fussing for five years, he finally reached the conclusion, after comparing it with the alcohol thermometer and thermocouples. We found there wasn't enough difference to have any effect. Practically speaking we can use mercury thermometers.

In reference to Dr. Codman's question, I may say that we in New York enjoyed his recent talk very much. We learned what a real sociable and brilliant speaker he could be.

The idea of using some temperature indicating system other than thermocouples has occurred to some, and what has been used is not wax, but a mercury substance which changes color when heated. Nobody, so far as I know, has used wax, melting around 41 and 42 degrees C. I don't see why they should not melt, because we have obtained such temperature values as I indicated. Those values I think very accurate, because all heat was shut off.

DR. CODMAN: The reason I suggested the wax was that such wax as the dentists use, for instance, would have no metallic character at all, and currents would not be generated around it. The melting of it would be pretty positive proof that the tissue had been heated.

DR. BIERMAN: Well, we did not have them here. The thermocouples were used after the current was stopped and the apparatus taken away. We think even living tissue would hold its temperature sufficiently long to permit fairly accurate reading. I have a team of five workers, one reading the subcutaneous, another intramuscular, another skin surface temperature, and another applying the thermotherapy.

With reference to Dr. Feldman, I am very glad to hear of the results, which he says, were obtained by means of short wave currents.

Dr. McFee asks me whether there would be any particular advantage in using short wave currents applied through cavities, as in the rectum, for treatment of prostates. We find we can use them, if we use a condenser outside. We have not had much success with the electrodes having glass outside, and with the metal kept some little distance away from the glass walls.

We described this some four years ago in the *Journal of the Society of Experimental Biology in Medicine*, I believe in 1931. We inserted our electrode in the vagina, and connected it with the pick-up plate. You cannot hook it on directly without a condenser outside. We have felt that our results in the orifices of the body were so good with diathermy, that at the present time we see no reason why we should not use this as regular routine. The actual temperatures developed in the female vagina

and rectum we have described in an article in the *American Journal of Medical Sciences.*

The urine, after voiding, may be 105 or 106 degrees F. The mass of urine has the value of retaining its heat very well. You get selective heating of an inanimate mass within the body itself.

With reference to Dr. Resnik's question as to burns with the short wave apparatus, I have not seen them occur any more often, with the use of the tube apparatus than with the gap.

There is a manufacturer in New York, Professor Chaffee, who is using the quenched gap. His quenched gap principle seems to produce good results. So that clinically I think Professor Chaffee might be hesitant about criticizing that apparatus, inasmuch as I think he would tell you, if you asked him, that he is not familiar with the physics of that particular apparatus. But practically speaking, my own experience with that apparatus—we have used four,—has not shown any difference.

Now, with reference to the size of electrodes and dosage and so on, that Dr. Wilcox asked us about, one of the criticisms of these comparative tests of heating produced in tissue is based on the fact that we have no method of measuring the wattage of the current in the person's body. There is no exact method of measuring the exact wattage, and it is on the basis of measuring the same amount of wattage that we would establish a fair method of measuring results. The old idea was that no more than 100 milliamperes per square inch of surface of electrode should be used. There, too, we have a very inexact means of measurement. What we have to depend on practically, using short waves and diathermy, is the subjective sensation of the patient. As long as we keep well below that, with any patient not under anesthesia or who has no anesthetized areas to which current is being applied, we are quite safe. Not absolutely safe, because we ourselves have been guilty of fat burns, especially in treating the cavities in gonorrheal females, because of the tremendous amount of conductive heating in tissue whose resistance is so high. The possibility of that occurring with the short wave, judging from our experimental evidence, should be slight. We have had patients complain of sensations in the teeth, but we have not seen any great degree of discomfort, nor have we seen any damage from that.

CHAIRMAN LOWRY: At the end of the next paper and discussion, we will act on the report of the Nominating Committee.

DR. MCFEE, Chairman of the Nominating Committee: *Mr. Chairman*—The Nominating Committee submits the following nominations for the ensuing year: For Chairman, Dr. Philip Cook of Worcester; for Secretary, Dr. William G. Curtis of Wollaston.

CHAIRMAN LOWRY: Dr. Carty of the Cornell Clinic in New York is coming back home. This is the place where he received his early training, and this is the place where he tells me he always feels at home. At the Massachusetts General Hospital he had his start in x-ray. He has gone to New York, and with the new apparatus, and with his personal investigation, he has been studying the soft tissue radiography. He tells us today about this particular field: "Diagnostic Possibilities in Soft Tissue Radiography." We are glad to welcome you home, Dr. Carty.

(Dr. Carty then read his paper, illustrating it with lantern slides.)

DIAGNOSTIC POSSIBILITIES IN SOFT TISSUE RADIOGRAPHY*

BY JOHN R. CARTY, M.D.†

SYSTEMATIC exploration of the soft tissues by radiographic methods has been a relatively neglected field. Refinement of technic, improvement of machines and sensitive material have opened a wide field. In the pioneer days of x-ray some beautiful soft tissue radiographs were obtained but the results were far from being constant, and attention was centered largely on demonstrating bone detail. Comparatively recently there has been increased interest in demonstrating the soft parts with the same detail as bone. In many conditions, as valuable information may be obtained as in the examination of osseous tissues.

The essential principle is to use as low a voltage as possible consistent with adequate penetration and a high milliampere second ratio. Intensifying screens are used and the development is by sight. Careful attention to small details of technic insures success. A certain amount of experience is necessary which is readily acquired.

In order to estimate the exposure in a radiographic study of an extremity three zones may be recognized, viz., Zone 1. Consisting of skin, superficial fat and fascia, very small vessels, etc. Zone 2. The muscle structures, large vessels, nerves, etc., and periosteum. Zone 3. Solid bone detail. Zones 1 and 2 require different penetration. Zone 3 is the conventional bone technic.

In what way, then, may soft tissue radiography be of aid? The study of the vascular system in disease is greatly facilitated. Normal arteries may be visualized, especially at the flexures. The earliest calcification is readily detected. It is possible to show varicose veins. This is particularly important regarding the deep-seated ones, determining whether injection therapy should be used.

Radiography of soft tissue tumors opens a new and wide field of usefulness. Often valuable information can be obtained as to extent, location, and invasive properties, if any. In a few instances such as hemangioma there are certain fairly characteristic appearances which are of great help in diagnosis. These tumors have an irregular worm-like structure.

Breaking of the tumor through a capsule is very suspicious of malignancy. This can often be demonstrated.

The various muscle groups can be shown. This affords a good opportunity to study the

*Read at the Annual Meeting of the Massachusetts Medical Society, Section of Radiology and Physiotherapy, June 3, 1935.

†Carty, John R.—Radiologist-in-Chief, New York Hospital. For record and address of author see "This Week's Issue," page 544.

muscle structures especially in relation to the bone. Calcification within muscle is well shown. Occasionally rupture of muscles may be seen, particularly if in a favorable position. Early muscle atrophy becomes apparent many times before there is a reduction in size of the involved muscle groups.

Soft tissue infections, particularly gas gangrene, may be detected in an early stage thus permitting surgery to be instituted relatively early.

While the solid bone detail does not show very early periosteal changes, inflammatory or malignant conditions become apparent. Very early callus formation is often shown if the part is not too heavy.

Gall bladder shadows after the Graham test are denser, an advantage with oral cholecystography. There is often improvement in delineation of soft abdominal shadows over the usual technic. Improvement may also be noted in radiography of the larynx.

Obviously in many instances soft tissue radiography should be undertaken in conjunction with a conventional technic. It supplements but does not supplant the latter. The cardinal principle is to obtain detail not outline of the non-calcareous structures.

Conclusions. The principles of soft tissue radiography are briefly explained and indications for this type of radiographic exploration discussed.

DISCUSSION

CHAIRMAN LOWRY: Dr. Hampton of the Massachusetts General Hospital will open the discussion.

DR. AUBREY O. HAMPTON, Boston: As most of you know Dr. Carty has been working on soft tissue radiography for four or five years and there is no doubt that he has done some valuable pioneer work in this field. Today he has presented some excellent examples of what can be done by careful x-ray studies of the skin, subcutaneous and muscle tissues. I am particularly impressed by the quality of his lantern slide reproductions because the technique of soft tissue radiography is difficult and reproductions on lantern slides must be even more difficult.

I have not had much experience with radiography of the more superficial soft tissues except in so far as they are related to diseases of the bone. Roentgenologists can no longer interpret films of the abdomen by simply stating "There are no visible areas of calcification," because the soft tissues are also visible and must be interpreted. It is surprising how frequently tumors of the female pelvis, retroperitoneal masses and other soft tissue abnormalities are clearly demonstrated on a good radiograph of the abdomen.

CHAIRMAN LOWRY: Is there any further discussion of this paper? Any questions? Have you anything to add, Dr. Carty?

DR. CARTY: I would like to say that Dr. Hampton brought out a very important point. There is a great deal of soft tissue detail that can be seen on the conventional bone radiograph. I think we should become more soft-tissue minded. We have found it helpful to view these films by lights of various intensities and of various wave lengths.

I would like to reiterate a point Dr. Hampton made regarding showing soft tissue radiographs by lantern slides. We had to make over 100 lantern slides to obtain those I showed you. However, soft tissue radiographic technique itself is not overly difficult.

We are very much interested in this work, and feel that here is a field to add to the usefulness of roentgenologists. In several instances, for example, we have been able to make a positive diagnosis of a soft tissue tumor. We feel the work is in its infancy, and we need help in pursuing the various angles which this study I believe opens. I thank you.

CHAIRMAN LOWRY: We are very grateful for each of the speakers who came here today. This has been a good meeting. We are sorry we did not have the fourth paper.

I would like to say that we are starting something new this year. We have an exhibit under Physical Therapy Section, showing massage and a few of the simpler forms of physical therapy, primarily to get the general practitioner interested in the subject.

The Nominating Committee has brought in the two names presented to you just previous to the reading of the last paper. Are there any other nominations from the floor? (No response.) If not, do I hear a motion about these names?

DR. HAMPTON: I move that the chairman cast one ballot.

(The chairman cast a ballot for the nominees.)

CHAIRMAN LOWRY: Dr. Philip Cook will be Chairman for next year and Dr. William G. Curtis the Secretary. I so declare them elected. Dr. Cook, will you stand up? Dr. Curtis?

Dr. Cook, you are now the chairman. Fellow-members, he has done a good job as secretary this year, and will make us an excellent chairman.

DR. COOK: Gentlemen, I want to thank you most heartily for this honor. I will try to carry on as well as my able predecessor. Is there anything further to come before the Section? If not, I will declare the meeting adjourned.

BOSTON TEST CHART

50 FEET

40 FEET

30 FEET

20 FEET

Suggestions for Use of Chart

For testing the vision of children in the school, the chart on the reverse side is especially adapted, and for the following reasons:

1. The symbols conform more nearly to physiological requirements for test objects than do letters; and more satisfactory results have followed wider spacing of the smaller symbols.
2. The chart is practically unlearnable.
3. It can be used in testing pre-school age groups, illiterates, mutes, etc.
4. Its size will permit it to be kept clean in an envelope, without folding.

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1. The chart should be hung on an easel, blackboard or other device, near a window, but not in direct sunlight, at right angles to the window. (It might even be hung in window-casing.) If one end of the room is brighter than the other, hang the chart near a window at the brighter end. Height of chart should be about level of average child's head. If there is glare from windows between the chart and the child, the lower half of window may be covered, or shade drawn. This rarely bothers unless the child, standing at the twenty foot line, is abreast of a window. (Glare is a brightness, within the field of vision, of such an excessive character as to cause discomfort or interfere with vision.)

2. Measure accurately a distance of twenty feet from chart, along windowed wall, placing a thumb tack or chalk mark on floor every five feet. Procure one or more stiff cards, 3 x 5 inches.

3. Having arranged for some one (teacher, nurse, or child) to point to the symbols, have the child toe the twenty foot line. Always test the right eye first. If the child wears glasses, ask if he has better vision with or without glasses. If better with glasses, test with glasses on, recording vision thus:

Right eye	Left eye	
20/20	20/30	with glasses.

If better without, test with glasses off.

4. Take position to the side and slightly behind the child, cover left eye by holding the longer side or edge of card against side of the nose, with the left hand; support the child's head lightly with the right hand.

5. Your assistant now points to any symbol on the top line, and the child semaphores the direction in which the arms point. If correct, the assistant then points to any symbol on the second line, and so on to the fourth line where at least two symbols (one with arms vertical and one with arms horizontal) must be seen before vision of 20/20 is recorded. The left eye is tested in the same manner. Supporting the child's head enables you to detect any head movement which might permit the child to see with the covered eye.

6. If the child can see only to the third line, vision is recorded 20/30 in that eye; if to the second line 20/40; and if only the largest symbols, 20/50.

If the largest symbols cannot be seen, walk the child toward the chart (being sure to keep the other eye covered). Instruct the child to stop when he can see the largest symbols. When this is done, note the distance from the chart in feet, and record the vision using this as the numerator and fifty as the denominator, because the largest symbols can be seen by a normal eye at fifty feet. If, for example, the largest symbols can be seen ten feet from the chart, vision is recorded 10/50.

ROUTINE VISION TESTING OF SCHOOL CHILDREN; A PLEA FOR STANDARDIZATION

BY JAMES J. REGAN, M.D.*

VISION testing of school children as part of the school program has become so general that it seems a pity not to take steps to standardize this important school function. By methods now in common use, uniformity of findings is impossible, with the result that children with defective vision are not detected, and many with normal vision are said to be defective; the former making it more difficult for the child to acquire an education, and the latter rousing the ire of indignant parents who are put to trouble and expense needlessly.

The most important single factor in the correct estimation of visual acuity is the test object used. With the selection of a test chart which will insure uniform results, only trivial faults in technic of conducting vision tests remain as a cause of error. These need only be called to the attention of the examiner, and for this purpose, the writer has printed on the reverse side of a new chart suggestions for its use, with illustrations.

Regarding the importance of the selection of a test object H. Kuchler (1835 or 1836), according to Ewing[1], was the first to suggest a standard for testing vision which could be employed by *anyone, anywhere.* Kuchler recommended

(1) "a measure of vision for those with weak eyes, and a measure that would be common to all practitioners";

(2) "a measure of vision by which the same patients could be tested at varying intervals of time, and a measure of vision that would be recognized by all physicians as being *exact*".

This is just as true now, a hundred years later, as when the pronouncement was made.

On this important point, Snellen[2] says:

"As the most suitable objects for measuring the visual angle we may select sets of three parallel lines and the correspondingly distinct figures, which can be geometrically deduced from them. These figures should be square, measuring, as far as possible, the same, both vertically and horizontally, and having interspaces equal in thickness to their component lines. Everything which might facilitate guessing at the shape of the figures must be avoided; etc."

Regarding the development of a variety of test objects, he wrote[3], "Finer types, less complicated letters, and forms which are not square have been proposed; thus losing sight of the principle which is particularly insisted upon,—viz., that the letters should, as far as possible, possess the same order of distinctness as our three equally thick parallel lines with equal interspaces. It is indeed a pity that it appears to be impossible to keep to one uniform scale by which visual acuity shall be tested."

The writer agrees that Landolt's broken ring is superior as a test object to Snellen's three parallel lines or its modification developed by Pergens[1] which resembles the letter E, but its use with school children is not satisfactory.

Of capital letters used as test objects, Jackson[4] said, "as a test for visual acuity they probably afford the poorest and most inexact standard on which any scientific observations are now based. They possess two essential defects as a scientific standard:

"First, the different letters, when made as uniform as possible, are visible from different distances;

"Secondly, they can readily be committed to memory."

After studying the problem for two years, the Committee on Standardizing Test Cards for Visual Acuity[5] reported as follows: "The work of the Committee has served to emphasize the unfitness of the alphabet as a standard of visual acuity."

They found the letter B had about the same visibility as Landolt's broken-ring, while all other letters were more easily seen, and L most easily visible. A rating table based upon visibility gave L .71, T .74, O .80, E .85, H .92, B 1.00.

The same Committee reporting in 1917[6] reduced the value of letter L to .62 and increased B to 1.15, compared with the broken-ring.

Of letters of the alphabet, only eighteen were found suitable, but even these eighteen have different degrees of visibility. Manifestly the fewer letters used, the more easily they can be committed to memory. Cowan[7] suggested modifying the shape of certain accepted letters in an attempt to have them conform more accurately to the Snellen scale; but, in doing so, altered the form to such an extent that they were no longer familiar to the patient. Familiarity with the letters of the alphabet incidentally, is the chief reason for their continuance in favor as test objects. Regarding the non-serif E, which has a very high rating as a test object and which also has been used, pointing in different directions, as an illiterate symbol, Cowan has this to say: "The short middle bar changes the outline which aids in determining the position of the symbol, thereby reducing its value as a test object."

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The 1916 report of the Committee on Standardizing Test Cards for Visual Acuity[5] mentions several factors which resulted in varying visibility of letters on several charts, one of which was "proximity of neighboring letters"; and while no further mention was made of this factor, it has been the writer's experience that children without eye symptoms and with no refractive error could see the symbols on either end of the twenty-foot line, but failed to see the symbols between. It appears then that while most test charts have been printed with a five minute interspace separating five minute test objects, there is nothing contained in Snellen's original monograph[8] suggesting spacing of symbols, and a larger number of children, with normal eyes, have been able to see all the symbols on the twenty-foot line when a chart, with twenty-foot symbols spaced twelve minutes apart, was used.

Inasmuch as the development of the Boston Test Chart (the test object was suggested by Ed. Pergens of Belgium, 1863[1]) as well as the technic for conducting vision tests resulted from work done in the schools of Boston, the use of the chart and the method of conducting tests is especially recommended for testing vision of school children. Note:—The Department of Education, Commonwealth of Massachusetts, has been furnishing Pergens' symbol charts to the schools since 1917.)

The chart measures 8″ x 10½″; is printed on 12-ply stock; its size permits its being kept clean in an envelope, without bending or breaking, when not in use. Its front surface contains four lines of test symbols, accurately drawn to Snellen's scale, which resemble the letter E, and each symbol points in one of four directions, up, down, right and left. The upper line contains symbols which subtend an angle of five minutes at fifty feet; the second, third and fourth lines contain smaller symbols which subtend angles of 40, 30 and 20 feet respectively. The reverse side of the chart contains suggestions for the use of the chart, with three illustrations, which we feel make it ideal for the teacher, nurse, medical inspector, or other school official conducting the test, to refresh their memories upon the important points. This is deemed desirable inasmuch as, in most cases, the chart is used but once a year.

Snellen stated that "The most suitable illumination for the examination of visual acuity is average daylight, or artificial light of about the same intensity."[9]

The writer has found average daylight, which according to Luckiesh[10], ranges from 100 to 300 foot-candles at the window casing, most satisfactory, is available during most of the school day, and requires no special apparatus.

A copy of the chart, with text and illustrations on reverse side, is offered herewith.

REFERENCES

1. Ewing, A. E.: Test objects for the illiterate. Am. J. Ophth. **3:** 5 (Jan.) 1920.
2. Snellen, Herman: On the methods of determining the acuity of vision. (In "System of Diseases of the Eye". Edited by Norris, W. F., and Oliver, C. A., Philadelphia, J. B. Lippincott Co.) **2:** 13, 1897.
3. Ibid: **2:** 15, 1897.
4. Jackson, Edward: International standard for testing vision and standardizing other visual tests. Tr. Sect. Ophth., A. M. A. 1914, p. 296.
5. Report of committee on standardizing test cards for visual acuity. Tr. Sect. Ophth., A. M. A., 1916, p. 383.
6. Report of committee on standardizing test cards. Tr. Sect. Ophth., A. M. A., 1917, p. 347.
7. Cowan, Alfred: Test letters which comply with the physiological requirements of a visual test object. A. J. Ophth. **11:** 625 (Aug.) 1928.
8. Snellen, Herman: Same as reference No. 2, pp. 11-29.
9. Ibid: p. 17.
10. Luckiesh, Mathew: "Magazine of Light", April, 1935.

Note:—The writer wishes to acknowledge with thanks the valuable aid in the preparation and printing of the chart given by Mr. Richard B. Barry, Head of the Printing Department, Boston Trade School, and the generous endorsement of Dr. James A. Keenan, Director of School Hygiene, Boston Public Schools.

MASSACHUSETTS MEDICO-LEGAL SOCIETY

ARSENIC IN HUMAN TISSUES AND FOOD ANIMALS*

I. So-Called Normal Arsenic

BY WILLIAM F. BOOS, M.D.,† AND A. BENJAMIN WERBY, B.S.†

INTRODUCTION

IS arsenic a normal constituent of the human body? This question was first propounded in 1841, by Orfila[1], whom we may well consider the father of modern toxicology. After that the subject of normal arsenic received little attention till toward the end of the nineteenth century when the French school, represented chiefly by Gautier[2, 3, 4] and Bertrand[5], became actively interested in the problem.

The results obtained by the French school, which tended to show that arsenic was normally present in a number of human organs, were strongly contested by the German school, of which Hödlmoser[6], Ziemke[7], Cerny[8], and Kunkel[9] were the chief exponents. The German investigators claimed that although traces of arsenic may be found occasionally in some human organs, that more often it is entirely absent and could not therefore be considered a normal constituent of the human system.

The controversy seems to have ended with Kunkel's declaration in 1905, that as far as forensic medicine is concerned, there is no such thing as normal arsenic. We believe that this

*Read in part at the Meeting of the Massachusetts Medico-Legal Society, June 4, 1935.

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statement holds good today, and shall refer to it later. Kunkel does not deny the possibility that traces of arsenic may be present more or less constantly in the organs, but he does not attach any importance to it. Since the days of the controversy, much work has been done on the subject and we think that the consensus among modern authors is that the French school did not prove its contention of normal arsenic, and that the German school did not disprove it.

In 1923, Billeter and Marfürt[10], two Swiss investigators, employed a painstaking and very sensitive method which enabled them to find minute amounts of arsenic in all the human tissues which they examined. Their work was done on twenty-four cadavers of persons ranging in age from birth to seventy years. They estimated that arsenic makes up about one ten-millionth of the body weight. The body of a person weighing 150 pounds would, therefore, contain one-tenth grain of arsenic. They found further that the quantity of arsenic in the tissues increases with age, a finding which in a sense we can bear out.

In order to demonstrate the presence of arsenic in the tissues, these authors used as a rule twenty grams of material. Now, of course, the more material used, the better the opportunity to find arsenic. However, for forensic purposes a proceeding such as theirs would not be suitable, since the object of a forensic investigation is to demonstrate either poisoning by arsenic or the absence of arsenic in the tissues. That is to say, the method used must show either an amount of arsenic which is incompatible with life or none at all. This object may be attained in practice by using only five grams of material for each determination. With this amount of material normal tissues yield a negative result, while those of a victim of arsenical poisoning yield a substantial reading for arsenic in each organ. In this sense, therefore, the dictum of Kunkel that the presence of so-called normal traces of arsenic in the tissues does not affect the results of forensic investigations for this metal, comes into its own.

Billeter and Marfürt have demonstrated that traces of arsenic are actually present in all human tissues, but their work has not thrown any light, so far, on the problem why the arsenic should be there. The term "normal" implies that the presence of arsenic in the tissues is necessary for the proper functioning of the body cells, that the arsenic is not "accidental" and is not due merely to the fact that all food and drink contain so much of the poison that it is impossible for the system to be at any time free from it.

Guthmann and Grass[11], who used an exceedingly hypersensitive method for the analytic determination of arsenic, tend to show that the metal does play some part in normal life processes. They found that (1) the blood of all women contains on the average 0.638 parts per million of arsenic during the intermenstrual or "normal" period, with but slight variations; (2) at the time of menstruation the arsenic content rises on the average to 0.925 parts per million; (3) with pregnancy the arsenic content of the blood rises on the average to 1.44 parts per million; (4) the arsenic content of the blood reaches its highest point between the fifth and sixth months of pregnancy; (5) that after that it diminishes slowly, but contains throughout pregnancy more arsenic than the blood of the non-pregnant woman; (6) the arsenic content in the blood of women suffering from carcinoma is forty-three per cent higher than that at the intermenstrual period of normal women.

Based on the fact that the arsenic in the blood is increased by menstruation, pregnancy and new growth, the authors assume that the increase of arsenic is directly related to the process of growth and cell proliferation, and that there may be a causal connection.

If the facts found by Guthmann and Grass are borne out by future investigators, their work will rank as fundamentally important. At present, however, their results cannot be accepted without reservation.

Several years ago, we became interested in the deposition of arsenic in hair and bone. From a forensic point of view, the arsenic in hair has no value in acute death from arsenic, but that in the bone is very important.

Considering first the hair, we find, to begin with, that all hair contains arsenic; that is to say, arsenic determinable by ordinary forensic analysis. This arsenic is being constantly excreted by the hair which constitutes an important organ of elimination for this poison, but the expulsion of arsenic by hair is a comparatively slow process at any time. The arsenic is taken up by the roots of the hair where it is fixed, and, as the hair grows, any of the metal which has been absorbed grows out with it. The growth of the hair is on the average, six inches a year, or one eighth inch a week and less than one sixteenth inch in three days. The three day period is chosen by us because deaths from acute arsenical poisoning may occur in anywhere from a few hours to three days after the ingestion of the poison. It will be seen that a maximum growth of hair of one sixteenth inch in acute arsenical poisoning, will not be high enough out of the scalp to be removed by cutting.

ARSENIC IN HAIR

A sample of hair was taken at an autopsy performed by Dr. John Paul Reardon, Medical Examiner of Middlesex County, on Miss Alice Porter. The tress of hair was thirteen inches long. It was divided into three equal parts,

proximal, midway, and distal. The results are given in table 1.

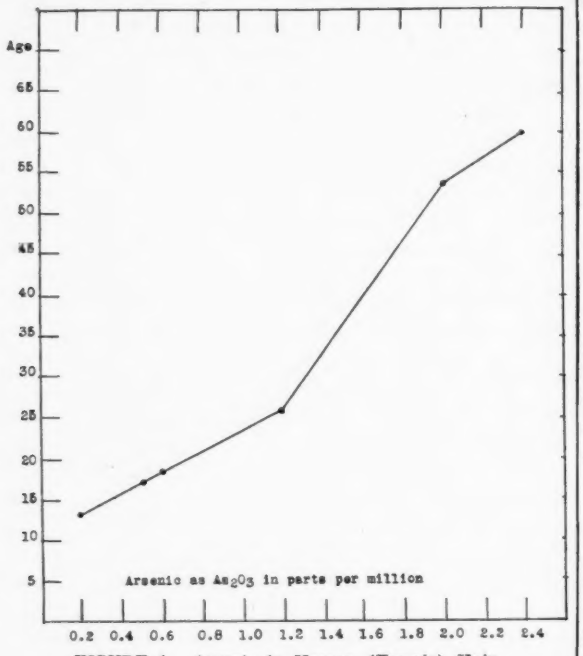

FIGURE 1. Arsenic in Human (Female) Hair.

TABLE 1

Part of Hair	Arsenic as As_2O_3 in parts per million
Proximal	1.4
Midway	2.4
Distal	2.0

From another autopsy performed by Dr. Reardon on Mrs. Elizabeth Stollicker, samples of hair were taken and examined. The results are listed in table 2.

TABLE 2

Part of Hair	Arsenic as As_2O_3 in parts per million
Proximal	3.0
Midway	3.1
Distal	2.7

The very high values obtained in these two cases, prompted us to investigate the hair of healthy living persons, who had never been subjected to arsenic therapy. We analyzed the hair of girls of thirteen, seventeen, eighteen, and twenty-six years of age, and that of a woman aged sixty. In these samples, merely the distal hair was examined. The results are given in table 3.

Several examinations of hair taken from fur, which were made by one of us (W.), did not show any appreciable quantities of arsenic. The probable reason for this is to be found in the environment of the fur bearing animals in which spraying with arsenic compounds does not occur.

TABLE 3

Name	Age	Arsenic as As_2O_3 in parts per million
J. W.	13	0.2
P. M.	17	0.5
G. P.	18	0.6
S. M.	26	1.2
A. Porter*	53	2.0
M. B.	60	2.4

*We have included Miss Porter's hair (see table 1) but have omitted Mrs. Stollicker's hair (table 2) from table 3 because the arsenic in it was abnormally high and suggested some arsenical medication during the last year or so of her life. The samples of hair recorded in this table (3) show the interesting fact that the deposition of arsenic in the hair increases directly with age (figure 1).

SOURCES OF ARSENIC IN FOOD

What is the cause of this increased amount of arsenic in hair? The only logical answer is that the food which we eat today contains more arsenic than was formerly present in food. Remington[12] has noted that the arsenic of the body is usually attributable to food, because of (1) chemical treatment in manufacture, (2) absorption by plants from the soil, (3) presence in sea food and (4) the widespread use of arsenical sprays in America, this having an important bearing on the point of the arsenic mechanically carried and the absorption by the plant as well. Headden[13] found that our virgin soils contain from two and one-half to five parts per million of arsenic and the underlying marl four to fifteen parts; and that the crops grown on such soils, and the animals fed on these crops contain arsenic. Other investigators have reported the finding of arsenic in soils of other localities.

In 1933, Myers and others[14] published their results of the analyses of a number of the common vegetable foods purchased in city markets. These are summarized in table 4, and are recalculated to arsenic as arsenic trioxide.

TABLE 4

Variety	Arsenic as As_2O_3 in parts per million
Broccoli leaves	0.3—0.66
Broccoli	0.00—0.15
Beet greens	Traces
Cabbage	0.00—0.19
Carrots	0.00—0.17
Celery	0.00—0.26
Egg plant	0.00—0.21
Lettuce	0.00—0.17
Lima beans (green)	0.00—1.25
String beans (green)	0.00—0.05
Fruits	0.00—0.22

In 1933 White[15] reported the analyses for arsenic, made in the laboratories of the U. S. Food and Drug Administration, of a number of American marine foods. These results are extremely interesting, as they disclose a source of much arsenic. The data are recalculated to give arsenic as arsenic trioxide, and are shown in table 5.

TABLE 5

Variety	Arsenic as As_2O_3 in parts per million
Cod	2.0— 5.4
Eels	2.6
Haddock (smoked fillet)	5.6
Mackerel (fresh)	1.9
Prawns	17.8
Sardines (canned)	1.5— 2.9
Irish moss	2.0— 8.4
Clams	1.5— 2.6
Crab meat	2.0—11.0
Oysters	1.4— 2.4
Lobsters	2.3—18.0
Shrimp	2.4—11.0

Much larger amounts of arsenic have been found by Chapman[16], who reported the presence of relatively enormous quantities in crustaceans from the coastal waters of the British Isles. In lobster, he found an average of over 40 parts per million in the fresh meat, and in one sample as high as 110 parts per million were recovered.

The arsenic content of American cod liver oils offers some startling information. Holmes and Remington[17] in their examination of twenty samples of American cod liver oils, comprising six geographical types, found very high amounts of arsenic. In view of the widespread use of cod liver oil, particularly by babies and young children, a large quantity of arsenic is being consumed by the very young. The average arsenic content of the oils is calculated to the trioxide and will be found in table 6.

TABLE 6

Source	Arsenic as As_2O_3 in parts per million
Massachusetts	1.9
Maine	1.8
Deep Sea	4.4
Nova Scotia	4.2
Newfoundland	3.7
Quebec	3.2

ARSENIC IN BONE

In the examination of human bone in poisoning cases, we sought to determine by the amount of arsenic present, what relation the quantity found bore to the duration of life after the poison was ingested. Our study seemed to show that when the individual lived only a few hours the amount in the bone was quite small, whereas the bone of those cases who had lived several days, showed a substantial quantity of arsenic. Further to study this question, we examined the bones of food animals, purchased at a market. They included chicken, lamb, veal, pork and beef, and we have tabulated the results under table 7.

TABLE 7

Variety of Bone	Arsenic as As_2O_3 in parts per million
Chicken	2.8
Lamb	3.2
Pork	3.2
Veal	1.6
Beef	8.0

It will be noted that these figures are quite high, particularly that for the bone of beef cattle. The figure for veal bone is so much lower than that for beef bone because the animal is very much younger.

ARSENIC IN FOODS

We also examined a number of other foods for their arsenic content and listed the results in table 8.

TABLE 8

Variety	Arsenic as As_2O_3 in parts per million
Sugar (table)	1.4
Salt (table, shaker)	0.01
Egg (hen) nearby	1.8
Starch (corn)	0.9
Cocoa	1.2
Calf's liver	0.4
Hamburger (beef)	1.0
Chuck (beef)	1.6

ARSENIC IN TOBACCO

We examined two popular pipe tobaccos and two well-known cigarette tobaccos.

TABLE 9

Sample	Arsenic as As_2O_3 in parts per million
Tobacco (pipe) "A"	13.3
Tobacco (pipe) "B"	9.5
Tobacco (cigarette) "C"	11.0
Tobacco (cigarette) "D"	9.0

It is interesting to note that Remington[12] examined pipe tobaccos and found arsenic present to the extent of from six to thirty parts per million, while Myers and others[14] reported that in their examination of seven different tobaccos, the arsenic ranged from none to 1.65 parts per million. Our examinations of smoking (pipe) tobaccos agree with those of Remington; it would appear, therefore, that the results of Myers and others are perhaps too low and do

not show the true arsenic content of tobacco. Because of the daily use of vast quantities of tobacco in our lives, the figures as shown in table 9, tabulated and calculated to the trioxide, will be of value as indicating an important source of arsenic.

TABLE 10

ARSENIC IN PIPE TOBACCO

Sample No.	Reported by	Arsenic as As_2O_3 in parts per million
2	Remington[12]	17.0
5	"	19.4
7	"	17.0
9	"	21.3
10	"	18.6
13	"	7.9
14	"	38.2
B	Myers and others[14]	1.65*
C	" " "	0.66*
D	" " "	0.73*
E	" " "	0.14*
F	" " "	0.62*
G	" " "	0.99*
H	" " "	0.59*

*These figures represent the greatest amounts found.

HEALTH HAZARDS FROM ARSENIC AND LEAD

According to Myers and others[14] the high arsenic found in broccoli, is indicative of its danger as a food. They state that some time ago, broccoli was served at a dinner given by a large group of medical men and approximately 100 of the individuals present suffered later with varying degrees of gastrointestinal symptoms; several had to be sent to the hospital. Arsenic was found in the broccoli. These authors further say, as a result of data collected over a period of fifteen years, that the elimination from the body of arsenic (and of lead) in any amount is of clinical significance, especially if there are symptoms which can be attributed to either metal. However, they feel that the amount of arsenic excreted is not a reliable guide concerning the extent of the physiological injury that has been wrought, because in some individuals there is a tendency to retention while, in others, there is rapid excretion. They believe that each and every one is exposed to metallic intoxication. According to them, some of the symptoms which should appear as a result of metallic poisoning from spray residue are fatigue, headache, vertigo, irritation of the eyes, pharynx and digestive tract, neuritis, dermatitis, blood vessel changes, possibly associated with vascular disturbances of middle and late life, pigmentation, paralysis, disturbances of locomotion, vomiting, dyspepsia, burning and griping abdominal pain and cramps.

In a second paper we expect to show (1) the amount of arsenic found in individuals who have not been subjected to arsenic therapy, that is to say, cases in which death was accidental or due to natural causes; we shall report (2) our examinations of the various organs of food animals for their arsenic content; and (3) the complete findings of arsenic in most organs of a number of persons who died as the result of acute arsenical poisoning. In this paper we shall describe in detail the procedure which we employ for the determination of arsenic in organ material, as well as tests of the method.

SUMMARY

Arsenic is not shown to be a "normal" constituent of the human body, but is present in minute amounts due to ingestion with food. At the present time the arsenic content of food, both solid and liquid, is too large and must be viewed as a menace to the general well-being.

REFERENCES

1. Orfila: Recherches médico-légales et thérapeutiques sur l'empoisonnement par l'acide arsénieux. Paris, 1842. de Méd., Paris **41-42:** 561 (Nov.) 1899.
2. Gautier, A.: Sur l'existence normale de l'arsenic chez les animaux et sa localisation en certains organes. Bull. Acad. Localisation élimination et origines de l'arsenic chez les animaux. Bull. Acad. de Méd., Paris **43:** 116 (Feb.) 1900.
La fonction menstruelle et le rut des animaux. Rôle de l'arsenic dans l'economie. Bull. Acad. de Méd., Paris **44:** 190 (Aug.) 1900.
3. Gautier, A.: Présence de l'arsénic en proportions notables dans tous les végetaux à chlorophylle de la classe des Algues et dans les Sulfuraires. Comp. rend. Acad. d. sc. **129:** 189, 920, 1899.
Localisation, élimination et origines de l'arsenic chez les animaux. Compt. rend. Acad. d. sc. **130:** 284, 1900.
La fonction menstruelle et le rut des animaux. Rôle de l'arsenic dans l'economie. Compt. rend. Acad. d. sc. **131:** 361, 1900.
4. Gautier, A.: L'arsenic existe normalement chez les animaux et se localise surtout dans leurs organes ectodermiques. Compt. rend. Acad. d. sc. **134:** 1394, 1902.
Présente les observations suivantes. Compt. rend. Acad. d. sc. **135:** 812, 1902.
L'arsenic existe-t-il dans tous les organes de l'economie animale? Compt. rend. Acad. d. sc. **137:** 295, 1903.
5. Bertrand, G.: Sur la recherche et sur l'existence de l'arsenic dans l'organisme. Ann. de l'Inst. Pasteur, Paris **16:** 553, 1902.
Nouvelles recherches sur l'arsenic de l'organisme; présence de ce métalloïde dans la série animale. Ann. de l'Inst. Pasteur, Paris **17:** 1, 1903.
Sur l'existence de l'arsenic dans série animale. Compt. rend. Acad. d. sc. **135:** 809, 1902.
Sur l'existence de l'arsenic dans la série animale. Bull. d. l. Soc. Chim. d., Paris **27:** 1233, 1902.
6. Hödlmoser, C.: Enthalten gewisse Organe des Körpers physiologischer Weise Arsen? Ztschr. f. physiol. Chem. **33:** 329, 1901.
7. Ziemke: Über das Vorkommen von Arsen in menschlichen Organen und seinen Nachweis auf biologichem Wege. Vierteljahrsschrift f. gerichtl. Med. **23:** 51, 1902.
8. Cerny, Karl: Ueber das Vorkommen von Arsen im thierischen Organismus. Ztschr. f. physiol. Chem. **34:** 408, 1902.
9. Kunkel: Beiträge zur Frage des sogenannten normalen Arseniks. Ztschr. f. physiol. Chem. **44:** 511, 1905.
10. Billeter, O., et Marfurt, E.: De la teneur normale en arsenic dans le corps humain. Helvetica Chimica Acta **6:** 780, 1923.
11. Guthmann, H., und Grass, H.: Über den arsengehalt des Blutes der Frau. Arch. f. Gynakol. **152:** 127, 1933.
12. Remington, R. E.: A hitherto unsuspected source of arsenic in human environment. J. Am. Chem. Soc. **49:** 1410, 1927.
13. Headden, William P.: The occurrence of arsenic in soils, plants, fruits and animals. Proc. Colo. Sci. Soc. **9:** 345, 1910.
14. Myers, C. N.: Thorne, B.: Gustafson, F., and Kingsbury, J.: Significance and danger of spray residue. Indust. & Engin. Chem. **25:** 624, 1933.
15. White, W. B.: Poisonous spray residues on vegetables. Indust. & Engin. Chem. **25:** 621, 1933.
16. Chapman, A. C.: On the presence of compounds of arsenic in marine crustaceans and shell fish. Analyst **51:** 548, 1926.
17. Holmes, A. D., and Remington, R.: Arsenic content of American cod liver oil. Indust. & Engin. Chem. **26:** 573, 1934.

DISCUSSION

PRESIDENT GAY: Dr. Boos's paper is now open for discussion, and I am sure he will be pleased to answer any question which any of you may have.

DR. CANAVAN: How much arsenic is there in tap water?

DR. BOOS: I think the quantity is negligible. We have never made analyses of it here. But I want to make a great many examinations of this kind because I think it is important to continue this work. It is almost an open territory, a new field of work, and there is a great deal to be learned by the analysis of many things that enter into our lives.

A MEMBER: You spoke of a good deal of arsenic being in cod liver oil. That is supposed to be a tonic and a medicine.

DR. BOOS: Yes, but no one knew it was there, as that is a very recent work done only a year ago. I think that none of the manufacturers had any idea that cod liver oil contained arsenic.

Ladies and Gentlemen—It is possible that the small amount of arsenic which Billeter and Marfürt found in the system, and it was surprisingly constant in the organs, serves a physiological purpose, but, for the moment, there is no proof of that. However, there may be proof forthcoming that some of the arsenic which we have in the system belongs there, but of course, not all of it because we ingest excessive amounts of arsenic in our foods and liquids. Wine and milk contain arsenic. Milk is bound to contain it because the cows eat so much sprayed grass and hay.

DR. JONES: I remember some years ago there was a death reported to this Society of a child who was thought, at the time, to have eaten some berries which had been recently sprayed with arsenate of lead. At that time, several mooted cases were brought to the attention of this Society.

I have actually forgotten whether this child was autopsied, but I think it was, and no arsenic was found.

Previous to that, however, the State Police and I roamed through the area with two other children, who showed us where the child had eaten the berries, but we couldn't find any particular berries except blueberries. There, we found great patches of luscious blueberries, absolutely white with arsenate of lead. I watched afterwards, and found that those berries were all picked and eaten. In fact, the next time I went there, I found three women picking them. They informed me, when I suggested that they might be uncomfortable after eating them, that they had been eating them all along, and they had not noticed any bad effects and they didn't see any harm in continuing to do it.

Now, you brought up the subject about beef cattle in your paper, but in southwestern beef, there is no arsenic, I am quite sure. And beef cattle bones would come almost invariably from the west or the southwest.

DR. BOOS: Most of the meat, of course, does come from the west and southwest. I am told, however, that western cattle are fattened for the market in New England, where there is much spraying.

DR. JONES: We went into the subject very carefully with the State Board of Health. We made it a regular study, and could find no report of any cattle having died from that.

DR. BOOS: I shall try to trace my information to its source. But there is a very interesting point which has been raised more recently. The Federal Government is beginning to think that the lead in arsenate of lead, is almost as important as the arsenic itself.

DR. JONES: I think it is.

DR. BOOS: That is why the Bureau of Chemistry is making such a strenuous effort to exclude lead from all sorts of food. They prohibited the sale of teas that were covered with lead foil, as it was said that the tea took up a considerable amount of lead. I think the presence of lead is probably due to the scraping of the tea against the surrounding lead foil because we made some analyses for a client, and we found that the tea in the middle of the package was almost lead free.

The government is considering seriously the exclusion of some delicacies from France because they come in a soldered can, which is considered to have quite an amount of lead in it. One product is sardines put out by a well-known house.

Just now, lead is the one thing that the Federal Government is most concerned with, and it may be that lead is quite an important feature in the poisoning from lead arsenate.

Many of the garden vegetables are not sprayed with lead arsenate. They are sprayed with Bordeaux mixture, the active principle of which is a copper hydrate. Small traces of this are often left, and you may have seen the light bluish-green deposit on the celery. This deposit is entirely harmless.

A MEMBER: With reference to Dr. Jones' remark as to the arsenic on the berries, in all probability the majority of people wash berries; that is, they soak them anyway, partly for ordinary matters of cleanliness, and then a great many times to take away the little bits of leaves and branches and little things like that. Wouldn't that take away the possibility of arsenic?

DR. BOOS: Have you ever tried to wash off the coating of arsenate of lead? It sticks; and it is difficult to remove. You would almost have to rub each berry separately to get it off. You will notice that after heavy repeated rain, there is still much white arsenate of lead on blades of grass and leaves.

DR. CANAVAN: Do you think there is any flour used in spraying, just ordinary flour?

DR. BOOS: Yes, flour is used to make this material sticky.

A MEMBER: I would like to hear from Dr. Leary or Dr. Magrath on that subject, just informally, if I could.

DR. MAGRATH: I haven't anything very original to contribute, as Dr. Boos has done all my analytical work, and we have had many experiences in the very acute and more prolonged instances of arsenical poisoning.

I want to take this opportunity of thanking Dr. Boos for his valuable paper, which is a real contribution, it seems to me, to the literature on this subject.

But, I haven't anything original of my own, because all the chemistry in cases of recent years where we have gone into the matter at all has been done by Dr. Boos. He has attended to all those matters.

DR. BOOS: I forgot to speak to you gentlemen about autopsies. Sometimes it may be a question of poisoning, and it would be very well, in every autopsy, if you would secure a sample of blood from the cadaver. The presence of arsenic in the blood of arsenical cases is very important, because it shows that the poison was still circulating in the blood, and that not all has been deposited in the organs. It is important, therefore, whenever you refer a case to a toxicologist, for any kind of poisoning for that matter, to give him blood, if you can. It is one

of the most valuable of the organic materials for forensic purposes. This is true also of the urine.

Many of the cases that come to us have been embalmed and there is no possibility of obtaining liquid blood. In these cases clots removed from the great vessels will answer very well. In unembalmed cases the Medical Examiner has an excellent opportunity to draw blood from one of the veins.

A MEMBER: I have done quite a little work in these matters, and sometimes when you can't find arsenic in the urine, can one still be excreting it for some time so that although you may not find it in the urine, you may find it in the hair? Have you any idea of how long it takes before it is so deposited?

DR. BOOS: It is not deposited quickly. It takes time. It is deposited much more slowly in the hair than in any of the other organs.

In the Porter case, the proximal hair contained about one and four-tenths parts per million: the mid-way hair contained two and four-tenths parts per million, while the distal hair contained two parts per million.

A MEMBER: And the same is true of the bones, isn't it?

DR. BOOS: The manner of arsenic deposition in the bone has not been determined.

A MEMBER: Then the chances are that if you don't find it in the urine, you will find it in the bones and the hair as the time passes?

DR. BOOS: Do you mean arsenic taken as a poison in food or as medicine?

A MEMBER: The possibility of there being arsenic there.

DR. BOOS: I feel that you can always find it in the urine. We have found it in every case we have examined.

A MEMBER: I would like to inquire how much blood it would be necessary to take?

DR. BOOS: One hundred cc. will do very well. If you can have more, of course, it is better.

You must be able to demonstrate in Court, with the wide-awake defense of today, that the system contained an amount of arsenic which would probably be fatal. That does not mean that you have to examine all the organs, but you should examine the blood, the internal organs, the bone, the skin, and the brain. The muscles are very important, because they make up such a large bulk of the body. Even the fat contains an appreciable amount of arsenic. Then, by computing the matter that you have examined you still have a considerable part of the body weight not analyzed. But from your figures, and from the part that you did not analyze, you estimate the arsenic to be such-and-such, whatever it is, for the whole body. Now, you may wonder why the body doesn't contain more than two and a half or possibly three grains of arsenic. I mean in the tissues themselves; you may find in the gastro-intestinal tract a great amount in addition, but that arsenic has had little to do with a person's death directly, because it is excessive arsenic that has not been absorbed. It is only the arsenic taken into the system through the blood stream that counts. After the system has taken up two to three grains, it cannot take up any more because death results. The average found is two grains. In a big man, you will probably find more and in a small woman, there may be less.

That is the reason for the uniformity of results in arsenical poisoning. As I have said, just as soon as the system has taken up enough to destroy the function of the cells, no more can be taken up. Up to that time, the system tries, very actively, to excrete the arsenic. That is why you always get a good test from cecal contents; the large intestine being one of the best of the excretory organs. In the intestine, you also find the arsenic which comes from the liver through the bile.

I don't know of any case of white arsenic poisoning since Dr. Magrath's case after the war, I mean the Archook Case.

The kidneys try hard to excrete the arsenic, therefore the kidneys are usually high in arsenic content.

In the cases of acute poisoning, the skin is also high in arsenic because it is excreted in the perspiration.

The organs that are particularly high in arsenic are the liver, kidneys, large intestine, small intestine, lungs, skin and brain.

If you find much arsenic in the muscles, it means, I think, recent administration, because it is still circulating in the muscles. The longer a person has taken to die, the less arsenic seems to be in the muscles. If on the other hand, the victim died a short time after the dose was taken, there is an appreciable quantity of arsenic in the muscles.

DR. JONES: You were speaking about the prophylaxis in arsenical spraying. I don't know whether the State law requires it, but very commonly, I have noticed that many trees are sprayed with arsenate of lead, and it is a deadly poison. I have seen this frequently.

DR. BOOS: What I meant, particularly, was that operatives should be restrained in spraying; they should not spray indiscriminately over such a wide territory, covering orchards, lawns and pastures with the arsenic. What is needed is more scientific spraying confined to individual trees. The sprayers, as a rule, are not highly intelligent or efficient and they do a careless job. I have seen many cases where the spray went all over the windows of the house, through open windows into the house, and over the lawn, the flowers and vegetable beds. I think such careless spraying should be stopped.

Probably the arsenic in tobacco also comes from spraying.

DR. JONES: It would seem as if it might be beneficial to find other material for spraying.

DR. BOOS: That would be a matter for the chemists and entomologists. Arsenate of lead is very cheap, while other things are expensive, and perhaps not so efficient. I think, however, that something should be done to prevent the increased amount of arsenic in our foods.

There is one point I would like to consider regarding arsenic in food. Where does the lobster get its enormous amount of arsenic? All sea foods contain some arsenic, but most is found in those of the sea foods which belong to the crustaceans. Crabmeat is high in arsenic, so are prawns and shrimp, and lobsters, of course, top them all. It would seem that the crustaceans have a particular habit of taking up arsenic that the other fish do not show to nearly the same extent. Haddock, for example, is comparatively low in arsenic; even deep sea haddock is fairly low and so are most of the salt water fish. But none of them are scavengers like the crustaceans, and it may be that animal and plant refuse which is thrown into the sea and is eaten by

the crustaceans is the source of their arsenic. The subject offers an interesting problem for the biologists. I have heard that fresh water fish do not contain as much arsenic as salt water fish. Perhaps then it is something that has to do with the sea itself.

A MEMBER: How much is contained in sea water?

DR. BOOS: I don't know.

Perhaps you have heard of the cases of arsenical poisoning from beer that they had in London. The presence of the arsenic was due to the commercial sulphuric acid which they used to convert cornstarch into glucose. The glucose was fermented to make the beer. Serious cases of poisoning resulted and there were some deaths due to large amounts of arsenic in the beer.

PRESIDENT GAY: Thank you very much, Dr. Boos. Now, ladies and gentlemen, in spite of what Dr. Boos says, that we shouldn't eat eggs, pork cuts, drink milk and a lot of other things, and now it's lobster and beef, I want to announce right here that I haven't developed an antipathy to all these things. For I know that I am still going to eat lobster.

TRICHINOSIS IN BOSTON*

BY WESLEY W. SPINK, M.D.† AND DONALD L. AUGUSTINE, SC.D.†

TRICHINOSIS is one of the commoner parasitic diseases in New England. For the past three years, we have been interested in the clinical aspects of the disease, and in skin and precipitin tests as aids in its diagnosis. The results of these studies are presented in more detail elsewhere[1, 2, 3, 4]. The purpose of this paper is to discuss some of the epidemiological phases of the disease in Boston with a consideration of preventive measures.

It is of interest that the first case of trichinosis reported in America was by Dr. Henry Ingersoll Bowditch of Boston in 1842, and appeared in the pages of the predecessor of this *Journal*[5]. Evidence of the disease was discovered at autopsy in a young man who died from a malignant growth. Bowditch states, "The muscles, and cellular membrane underneath them, seemed literally covered with myriads of minute white lines, looking at first sight like the ova of the common fly upon decaying animal matter."

Almost one hundred years have elapsed since Bowditch described his findings and, in the meantime, hundreds of cases of trichinosis have been recorded in American literature. While trichinosis is not so common as some infectious diseases, it occurs far more frequently than published reports indicate. In the statistical reports of infectious diseases which appear from time to time in this *Journal*, trichinosis is listed as a rare disease. This is in sharp contrast to the high incidence of the disease to which attention has been called recently as a result of observations made at routine postmortem examinations. Queen[6] in Rochester, New York, found, after examining the diaphragms in three hundred and forty-four consecutive autopsies, that fifty-nine (17.5 per cent) contained *Trichinella spiralis*. A similar study made on fifty-eight autopsies in Boston, Massachusetts, showed sixteen of the diaphragms, or 27.6 per cent parasitized. Riley and Scheifley[7] studied the diaphragms of cadavers in the Anatomy Department of the University of Minnesota, and found the incidence in one series to be 17.9 per cent and 20 per cent in a second series. As a result of these studies, it appears that the incidence of trichinosis in three large cities is probably rather high. It might be pointed out that in Queen's series of cases no antemortem diagnosis of trichinosis had been made.

During the past three years, we have obtained clinical data in sixty-five proved cases of trichinosis in Boston. Most of these cases were observed at the Boston City Hospital, but through the courtesy of Dr. James H. Means, patients were also studied at the Massachusetts General Hospital. It is to be noted especially that most of these infections were sporadic, and severe enough to require hospital care of the patients. If it could have been possible to observe other members of the families at home, the number of cases might well have been larger, as it is well known that individuals may be infected with the parasite, and yet have few or no symptoms.

Of considerable interest in the study of these patients was the variable symptomatology. Standard textbooks of medicine, in discussing the symptoms of trichinosis, usually divide the clinical course into three stages. The first stage, that of the development of worms to maturity in the intestine, includes nausea, vomiting, diarrhea, and abdominal pain; the second stage, the period of dissemination of the larval worms, is marked by muscle tenderness, edema of the eyes, and eosinophilia; while the third stage, or the period of encystment, is that of convalescence. But such was not the clinical course in most of the sixty-five cases. One patient was observed having only edema of the eyes and a fever. There were no gastrointestinal symptoms or muscle tenderness, and yet a biopsy of the gastroc-

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nemius muscle, when examined microscopically, showed four larvae per high power field. Another patient had an unexplained fever as the only complaint. Some patients had no gastrointestinal symptoms, yet they developed severe muscle pains. Others had gastrointestinal symptoms but no muscle pains. A most puzzling case was that of a young colored girl who developed a fever, and marked weakness of the muscles of the back, arms and legs. She was under observation for poliomyelitis until examination of blood smears showed a marked rise in the number of eosinophile cells. Microscopic study of a muscle biopsy revealed several recently encysted larvae. During the whole clinical course, she had no edema of the eyes, gastrointestinal symptoms, or muscle tenderness.

Since the disease manifests such a variable symptomatology, the diagnosis of the sporadic case may be very difficult. We have found the most valuable aid in diagnosis to be the presence of eosinophilia. Many persons were first suspected of having trichinosis because of the blood picture. Perhaps the reason why trichinosis is not recognized more often is that the routine examination of stained blood specimens is not done frequently enough in private practice or even in hospitals. The diagnosis may be made more difficult when eosinophiles are absent in the blood smear. One of us (W. W. S.[8]) has observed that eosinophiles may not be found in the blood of either trichinous animals or human beings when a secondary pyogenic infection is present. Thus in two of our patients who were under observation for one to two weeks before the correct diagnosis was made, it was eventually found that a secondary pyogenic infection had suppressed the eosinophiles, and it was only when the secondary infection subsided that eosinophiles appeared in the peripheral blood. Skin and precipitin tests have been very useful in the diagnosis of suspected cases. The skin test usually becomes positive after the second week of the disease, and the precipitin test between the third and fourth weeks.

Briefly, the diagnosis of trichinosis depends upon a careful history of the patient's illness, a complete physical examination, repeated examinations of blood smears for eosinophiles, and the use of skin and precipitin tests. In our experience looking for the larvae in the blood, spinal fluid or muscles is a waste of time and unnecessary if the foregoing procedures are carried out.

An analysis of the epidemiological data in these cases is desirable, as an aid in controlling the disease. Only one of the sixty-five cases terminated fatally. This occurred in an Italian laborer who had eaten about four pounds of raw salt pork over a period of several days. Death was due to an acute myocarditis and bronchopneumonia[4].

The distribution of the cases according to parentage is seen in table 1. It is interesting to note that no Germans are included, but this may be explained on the basis that there are relatively few Germans in Boston. Most epidemiological studies have pointed out that a large proportion of cases occurred in Germans, due to the fact that they consume a great deal of raw pork. Another point of interest is that not all the cases occurred in people of low intellect and social status. Seven cases occurred in the families of two prominent physicians.

TABLE 1

DISTRIBUTION OF SIXTY-FIVE CASES OF TRICHINOSIS IN BOSTON ACCORDING TO PARENTAGE

Parentage	Number of Cases
American	22
Italian	22
Irish	13
Jewish	5
Negro	2
Syrian	1
Total	65

It was found that thirty-three of the cases (52.3 per cent) occurred singly without other members of the families having symptoms. On two occasions, groups of five persons were found to have trichinosis, and in one instance eight Italians became infected after eating fried pork sausages made at home.

An endeavor was made to determine the source of the infection in every case. In thirty cases (46.1 per cent) no definite relationship could be found between the disease and the food eaten. In only three instances was the meat eaten in a raw state without any preliminary cooking. In the remaining cases, it is evident that although the meat was cooked, it was not cooked thoroughly. Cooked pork sausage was the cause of the infection in fifteen cases; nine were due to boiled ham; six to cooked pork chops; one to fried ham; and one to cooked pork spare ribs. It is significant that several patients became infected after eating meat that had passed inspection by Federal meat inspectors.

An effort was made on several occasions to determine the incidence of infected pork on sale in Boston markets. This investigation was carried out in coöperation with Dr. Frederick J. Bailey, Deputy Health Commissioner of Boston. Small specimens of raw pork and pork products were obtained from several local markets. These were digested in artificial gastric juice and a search was made for larvae in the sediment. Trichinae were not found in any of the samples of pork examined.

Our observations indicate that the mortality rate of trichinosis in Boston is low, with only one death occurring in sixty-five cases. The incidence of the disease appears about equally divided between those of American and of foreign parentage and not limited to those of low intellectual and social status. A majority of cases occurred in patients who had consumed cooked meat, and meat that had passed the inspection of Federal inspectors. From these facts, one might conclude that although the incidence of trichinosis is high, it is not a serious disease, and a suitable motto for its prevention would be, "Let the buyer beware and cook his pork thoroughly." But any clinician of experience knows that trichinosis may be a serious disease, leaving a patient prostrated for weeks. As for controlling the disease, it is well to consider some of the attempts that have been made.

Our knowledge concerning the parasite, Trichinella spiralis, is about one hundred years old. Richard Owen[9] is usually credited with its discovery in 1835. However, James Paget, while still a medical student at St. Bartholomew's Hospital, made careful sketches and dissections of the parasite[10] and called Owen's attention to his findings. These findings of Paget and Owen remained only of scientific interest until the brilliant work of the German pathologists, Virchow[11], Leuckart[12], and Zenker[13] about 1860, emphasized their pathological significance. In the years from 1860 to 1866, the people of Prussia and Saxony were almost in a state of panic because of fear of the disease[14]. A few years later the German Government instituted the method of examining microscopically the muscles of hogs killed for human consumption. This measure of prophylaxis against human trichinosis is still continued in Germany. After the system had been in use for several years at a considerable expense, it was found that the incidence of the disease had not been reduced according to expectations. The importation of unexamined American pork was blamed for its failure, and the importation of American pork to Germany was promptly prohibited. This materially affected the packing industry of our country, and in 1898 the United States Government sent Dr. C. W. Stiles to Germany to ascertain the value of microscopic examination of pork. His conclusions[14] after two years' observation showed that out of 6,329 cases of trichinosis occurring in Germany between 1881 and 1898, 3,388 cases with 132 deaths appeared to have been due to faults of the method of German inspection. Furthermore, such a system gave a false sense of security, and pork was eaten raw. It is interesting, as Stiles pointed out, that for Prussia alone the trichina inspection force in 1895 was almost as large as the entire regular army of the United States (27,089), and during the years of 1892 to 1895 the number of Prussian trichina inspectors was greater than the number of enlisted men then authorized by law for the United States army. He estimated that the trichina inspection for Germany would cost $500,000 to $1,000,000 more than the entire annual appropriation for the United States Department of Agriculture for that year. The United States Government inaugurated a similar system in pork for foreign export in order to regain the market, but discontinued it in 1906 because of the excessive cost and its relative inefficiency.

It is assumed now as a governing principle in the United States, that the consumer is himself responsible for the proper preparation of fresh pork and pork products that are usually cooked before eating. The packer is, however, under obligation to make sure that pork products to be sold as cooked products are properly cooked or, if of a kind customarily eaten without cooking, to make sure that the products are free from viable trichinae[15].

In 1914, Ransom[16] showed that encysted larvae of *Trichinella spiralis* are destroyed by cold. As a result of these and further studies by Ransom and his co-workers[17, 18] all pork products of kinds customarily eaten without cooking which are prepared in establishments operating under Federal supervision are specially processed to destroy trichinae and are thereby rendered safe without cooking by the consumer. The methods of processing include cooking, refrigeration and special curing. Because of the exactitude required in these processes, they can be carried out effectively only in establishments under Federal supervision. Methods of preparing pork other than cooking are not readily applicable in the home. Therefore, the only safe rule in preparing pork purchased on the market not intended to be eaten without cooking is to cook it thoroughly.

One is frequently asked whether the ingestion of pork is the sole cause of trichinous infections. As far as we know, the eating of improperly prepared pork is the usual source of trichinosis in human cases although severe and fatal cases from the consumption of bear meat have occurred recently in California[19, 20].

It is the current conception that one of the chief methods of infection in swine is the eating of trichinous rats which are alleged to be numerous where hogs feed upon garbage and offal. While it is known that swine readily eat dead rats thrown to them, our own observations made at both large and small piggeries have led us to question the generally accepted idea of the importance of rats as reservoirs of infection for swine. Never did we note any close association between swine and rats, even at feeding times. Garbage delivered to the piggeries was usually fed within a few hours to the pigs in their pens, runs and pastures. Rats were seen to feed only from temporary storage bins

or barrels or from the pig troughs after the hogs had left. At the time of slaughter in those piggeries in which the offal was fed back to hogs, this was immediately and completely devoured by the latter and at no time were rats seen attempting to approach it. It appears that the infection in swine may be chiefly of porcine origin (uncooked pork scraps and offal) and that the infection in rats may also be of porcine origin and transmitted through cannibalistic habits, but that the infection in the rat is seldom transmitted to the pig.

A survey (made by D. L. A.) for helminths in rats caught at piggeries and from the market districts, along the water front and at a large packing establishment in Boston supports this view. A total of two hundred and eighty rats was examined for helminths in this survey. Particular attention was given to the incidence of Trichinella spiralis. One hundred and ninety-three rats were trapped at four large piggeries located approximately twenty miles from Boston. Seventeen rats were caught at a packing house in Greater Boston and seventy were trapped in the market district and along the water front of Boston proper. Of the one hundred and ninety-three rats from the piggeries, only two were found trichinous, whereas nine or approximately 12 per cent of those from the market district and water front, and five or 42 per cent of the packing house rats were similarly infected. It is evident, therefore, that rats at these piggeries are not an important source of infection for the pigs.

Examinations of pigs for trichinosis were made at two piggeries. At one the food consisted largely of garbage collected from the residential districts of the town and, at times of slaughter, offal was fed to the remainder of the animals. Twelve young pigs which were to be slaughtered on the following day were given a skin test for trichinosis. All were negative by this test. At slaughter the diaphragms were obtained and examined after artificial peptic digestion. None were found trichinous. The second piggery was selected because three cases of trichinosis in man were known to have originated from it. Two large hogs which were to be slaughtered within the next few days and seven younger pigs, chosen at random as they fed upon garbage, were skin tested for trichinosis. One of these younger pigs developed a positive reaction while the tests on the others were negative. A precipitin test of the blood serum of this pig was likewise positive and the parasite was later demonstrated in the muscles. At this piggery the garbage was collected principally from small meat markets of the nearby city. A casual examination of the garbage held temporarily in barrels revealed pork scraps including a large piece of raw pork and several pieces of raw skin. It was evident that trichinosis in this piggery originated directly from garbage.

These observations have, therefore, led us to believe that trichinosis in pigs (at least in this locality) is usually the result of their ingesting trichinous pork either in garbage or in the offal at times of slaughter and that the infection in rats, although relatively rare at the piggeries, has its origin in trichinous pork scraps, and may be transmitted from rat to rat through cannibalistic habits but that its return to swine through rats seldom occurs.

A review of the cases of trichinosis we have encountered within the past five years in eastern Massachusetts shows that the majority originated from locally raised and slaughtered hogs. As a specific example, during February of this year, twelve cases of the disease developed in a single family in consequence of eating pork from a hog to which the family had fed garbage collected in the town (not included in this series).

Inasmuch as trichinosis in swine in this region appears to have its source in garbage and offal it would be advisable to encourage the feeding of cooked garbage and cooked offal, particularly where garbage is collected from market districts and known to contain raw meat scraps.

Although our one absolute protection against trichinosis is by thorough cooking of pork, the necessity of thoroughly cooking all pork is not generally understood. To many the stamp "U. S. Inspected and Passed" is a guarantee that that piece of pork is free from trichinae and can be used without fear. It is not a lay conception alone but one that has been held correct by authorities on foods and sanitation, and so stated in textbooks on Hygiene and General Science now used extensively in our High Schools.

As stated by Riley and Scheifley[7] "It is evident that there is still abundant need for educating the public regarding the source of trichinosis and the simple means of protection that may be taken against the infection." It would seem that one of the most effective means of bringing this information to the public is through the school.

It is possible that at some future day trichinous hogs may be eliminated from the market by means of the serologic tests, now valuable aids in diagnosing the infection in man. The observations made by Augustine and Theiler[1] have shown that these are more accurate than muscle examination. No false positive skin reactions were encountered in swine in Massachusetts, even when concentrated dilutions of the antigen were used, but under tropical conditions, in the Panama Canal Zone and Colombia, South America, typical positive reactions were frequently encountered in non-trichinous hogs when concentrated dilutions of the antigen were used. High dilutions which were still effective in producing a typical reaction in trichinous hogs failed to produce a reaction in hogs sensitive

to the concentrated dilutions. The tests appear specific but further studies are necessary before their practical application can be determined.

For the present, the control of trichinosis obviously rests with the housekeeper, which means that all pork should be cooked thoroughly before it is eaten.

REFERENCES

1. Augustine, D. L., and Theiler, H.: Precipitin and skin tests as aids in diagnosing trichinosis. Parasitology **24:** 60 (March) 1932.
2. Spink, W. W., and Augustine, D. L.: The diagnosis of trichinosis: with especial reference to skin and precipitin tests. J. A. M. A. **104:** 1801 (May) 1935.
3. Spink, W. W.: Clinical and pathological observations of the heart in trichinosis. J. Clin. Investigation **13:** 708 (July) 1934.
4. Spink, W. W.: Cardiovascular complications of trichinosis. Arch. Int. Med. **56:** 238 (August) 1935.
5. Bowditch, H. I.: Trichina spiralis. Boston M. & S. J. **26:** 117 (March) 1842.
6. Queen, F. B.: The prevalence of human infection with *Trichinella spiralis*. J. Parasitol. **18:** 128 (Dec.) 1931.
7. Riley, W. A., and Scheifley, C. H.: Trichinosis of man a common infection. J. A. M. A. **102:** 1217 (April) 1934.
8. Spink, W. W.: Effects of vaccines and bacterial and parasitic infections on eosinophilia in trichinous animals. Arch. Int. Med. **54:** 805 (Nov.) 1934.
9. Owen, Richard: Description of a microscopic entozoon infecting the muscles of the human body (*Trichina spiralis*). Proc. Zool. Soc. **3:** 23, 1835.
10. Editorial—"The discovery of *Trichina spiralis*." Brit. M. J. **2:** 610 (Oct.) 1930.
11. Virchow, R.: Ueber *Trichina spiralis*. Virchow's Arch. f. path. Anat. **18:** 330, 1860.
12. Leuckart, R.: Untersuchungen über *Trichina spiralis;* zugleich ein Beitrag zur Kenntniss der Wurmkrankheiten. Leipzig u. Heidelberg, 1860.
13. Zenker, F. A.: Ueber die Trichinen-Krankheit des Menschen. Virchow's Archiv. f. path. Anat. **18:** 561, 1860.
14. Stiles, C. W.: Trichinosis in Germany. U. S. Dept. Agric. Bureau of Animal Industry Bulletin No. 30, 1901.
15. Schwartz, B.: Trichinosis, a disease caused by eating raw pork. Leaflet No. 34, U. S. Dept. Agric., 1929.
16. Ransom, B. H.: The effect of cold upon the larvae of *Trichinella spiralis*. Science **39:** 181, 1914.
17. Ransom, B. H.: Effects of refrigeration upon larvae of *trichinella spiralis*. J. Agric. Res. **5:** 819, 1916.
18. Ransom, B. H., Schwartz, B. and Raffensberger, H. P.: Effects of pork-curing processes on trichinae. U. S. Dept. of Animal Industry Bulletin No. 880, 1920.
19. Walker, A. T.: Trichiniasis: report of an outbreak caused by eating trichinous bear meat in the form of "Jerky." J. A. M. A. **98:** 2051 (June) 1932.
20 Editorial: Trichiniasis from bear meat. Weekly Bull., Calif. Dept. Public Health, November 14, 1931.

TRICHINIASIS AMONG JEWS

BY HYMAN MORRISON, M.D.*

TRICHINIASIS is recorded as the diagnosis in seven cases at the Beth Israel Hospital in the past four years, four of the patients being Jews. This disease is not rare even under modern food control, but its occurrence among Jews is noteworthy and it indicates a change in an age-long dietary tradition. The pig has always been an unclean feeder and it is fair to assume that bitter experience was the basis for the specific injunction in the Mosaic code against the use of swine as food. Certainly there was no trichiniasis among Jews so long as they abstained from eating pork. With increasing lapse of dietary observance, however, we must learn to consider this disease in differential diagnosis even among Jews.

The four cases mentioned above are reported here with a view of emphasizing two points: First and chiefly, the occurrence of this disease among Jews, and secondly, the importance of bearing in mind this disease when confronted with cases of fever of apparently unexplained origin.

CASE 1. A traveling salesman of forty came to our attention after he had been ill with fever for about three and a half weeks. His only complaint was dull headache and malaise. At the beginning of his illness a swelling about the eyes had been noted. Examination on the day before he was sent to the hospital revealed no apparent explanation for the fever, but a stained smear of his blood showed an eosinophilia of twenty-five per cent. This was corroborated on his admission to the hospital, and a routine investigation for fever of unknown origin brought out no other findings. A biopsy from the deltoid and soleus muscles disclosed encysted trichina embryos. Questioning as to his diet disclosed that in his travels he had eaten various pork products. The temperature became normal at the end of the fourth week of his illness and he has been well since.

CASE 2. A man of forty-two was admitted to the hospital with a story of heartburn and sharp burning pain in the epigastrium for three weeks. On admission he was found to have fever, but this came down to normal four days later. Because a complete routine examination yielded no other data except an eosinophile count ranging between twenty-nine and sixty-one per cent he was questioned as to his diet, and the fact was brought out that he had eaten pork three weeks previously followed for several days by diarrhea and puffiness of the eyelids to which he paid no attention. A biopsy revealed encysted trichina embryos.

CASES 3 and 4. Husband and wife, both twenty-two years old. The wife was sent to the hospital with a provisional diagnosis of acute appendicitis. She had been ill for about a week with malaise and abdominal colic, at first localized in the right lower quadrant but subsequently diffuse. A routine blood examination showed an eosinophilia of sixty-eight per cent, and subsequently biopsy revealed encysted larvae of trichina. Her husband came in several days later. His story was that a week previously he became ill with fever, malaise, and abdominal distress and that four days later his eyelids became puffy and on the night before admission he had generalized muscular pain and soreness. At the hospital his eyelids were still puffy, he had fever, and his eosinophile count was fifteen to forty-three per cent. The history now brought out that both he and his wife had eaten pork a few days before the onset of their illness. His temperature subsided four days after he entered the hospital.

Of the four patients only one presented the classical picture of trichiniasis when first observed at the hospital. This was the last case mentioned. The diagnosis in his case was simple because it had already been made in the case of his wife whose symptoms were chiefly abdominal pain. After the finding of eosinophilia by routine examination muscle biopsy

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cleared up the diagnosis. The first case was puzzling because he showed fever of over three weeks' duration without any explanation, and in this case, also, a routine blood smear examination gave the clue.

If the possibility of this disease is borne in mind, the diagnosis should not offer any difficulty. Remittent fever with muscle pain and edema localized around the eyes should at once prompt examination of the blood for eosinophilia and a searching inquiry for a history of the ingestion of pork. Finding of encysted larvae through muscle biopsy or the skin or precipitin tests makes the diagnosis absolute. If the patient is seen after the edema has disappeared, or if the edema is so slight as to be overlooked, or if the muscle pain is slight or limited to special muscle groups, then fever alone is the dominant feature of the disease and the diagnosis may be baffling if the blood is not examined in a routine way. This accounts for the many failures in the diagnosis of such cases until the patients are taken to a hospital where routine blood examination gives the necessary clue.

SUMMARY

1. Four cases of trichiniasis among Jews, out of a total of seven, at the Beth Israel Hospital are cited briefly.

2. The diagnosis in all of them was obscure until a high eosinophile count gave the clue.

3. Because of the change in dietary habit, a diagnosis of trichiniasis should be borne in mind in cases of fever of obscure origin even among Jews.

THE ENERGY REQUIREMENT IN STRENUOUS MUSCULAR EXERCISE*

BY H. T. EDWARDS, A.A.,† A. THORNDIKE, JR., M.D.,† AND D. B. DILL, PH.D.†

STUDENTS of physiology are familiar with the report of Woods and Mansfield[1], that Maine lumbermen have an energy exchange of about 8,000 cals. per day. Workmen are rarely called upon for such a high level of sustained effort. However, strenuous muscular exercise requires increased metabolism over certain definite periods of time. It is of interest to determine in this day of organized amateur athletics the energy requirement of sustained effort in such a sport as American football. In the last edition of Bainbridge[2], the statement was made that football players lose weight on a diet of less than 7,500 cals. We now have to report that measurements made during the past two years on Harvard football players show that on 5,600 cals. body weight is maintained.

The menu at the Harvard training table is arranged by a trained dietitian under the supervision of one of the authors (A. T.). A varied diet unlimited in amount is provided. Lunch and dinner from Monday to Saturday noon are served.

Eight players were observed during three periods of several days each, one period in 1933 and two in 1934. Each item of food placed on the table was accurately weighed, and food residues were all collected and weighed. Weights of protein, fat and carbohydrate were calculated from standard tables[3, 4].

During the season of 1933 accurate estimates were made for lunch and dinner only, but in 1934 breakfasts also were served at the training table for six consecutive days. The average breakfast eaten during this period is shown in table 1 together with the estimated caloric intake between meals. The estimated *extra* calories were consistent from day to day and amounted only to about five per cent of the total food intake.

TABLE 1

FOOD INTAKE AT BREAKFAST AND BETWEEN MEALS

During six days of the 1934 periods eight men ate breakfast at the training table and reported all food eaten between meals. The caloric value of extras is small and even if in error by 50 per cent the total will be not greatly in error.

		Carbohydrates	Proteins	Fats	Total
Breakfasts	Cals.	699	122	582	1403
	%	50	9	41	
Extras	Cals.	131	36	121	288
	%	46	12	42	

We thus obtained, by addition of the average breakfast and estimated extras to the measured lunches and dinners for the three periods, the total caloric intakes shown in table 2. The weights of the players were observed daily as shown in table 3. There were the usual day-to-day fluctuations, but no significant net change in the average weight from Monday through Friday. It may be concluded, therefore, that these players had an average energy requirement of about 5,600 cals. during the periods studied. The average for the week may be slightly less because the players eat lightly on Saturday before the game (table 2) and are cautioned to eat a light dinner after the game.

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From verbal reports, Sunday appears to be a feast day and may in a large measure offset the low intake of Saturday.

An estimate may be made of the proportion of the total energy required for football. These sixteen men had a mean height of 184 cm. and a weight of 83 kg. which corresponds, according to accepted standards, to a basal metabolism of 80 to 84 cals. per hour, in other words to about 2,000 cals. per day. According to Rubner's figures[5] such an individual in light activity would require about 2,800 cals. per day. The difference attributable, directly and indirectly, to football is 5,600 — 2,800 = 2,800 cals. Deducting ten per cent (300 cals.) for loss through the urine and feces there remain roughly 2,500 cals. attributable directly and indirectly to football playing. Since the daily practice and the Saturday game average about two hours each, it follows that the increased requirement attributable directly and indirectly to an hour of football playing is one-half this quantity, or 1,250 cals. If this increased metabolism were limited to the period of play, football playing would involve an increase in the metabolic rate of about fifteen times normal. But the data collected by Lusk[6] indicate that the trained athlete is capable of increasing his resting metabolic rate only about ten-fold in any sustained effort. While an increase of fifteen times resting metabolism may occur in a marathon race during a period of two and one-half hours, such an effort could hardly be made six days a week. We accordingly assume a metabolism during play of 800 cals. per hour.

Since the metabolism of Rubner's student during his working hours is approximately 135 cals. per hour, this represents an increased metabolism of 800 — 135 or 665 cals. per hour, i.e., 2 x 665 = 1,330 cals. per day which is directly attributable to playing football. But the increased metabolism directly and indirectly attributable to playing football is 2,500 cals. per day. This amount less 1,330 cals. directly attributable to football gives 1,170 or in round numbers 1,200 cals. increased metabolism per day indirectly attributable to football.

Accordingly, a large part (roughly one-half) of the increased metabolism attributable to football occurs after the game is over. Only a

TABLE 2

FOOD INTAKE OF 8 FOOTBALL PLAYERS, 1ST WEEK,—1934

		Mon.	Tues.	Wed.	Thurs.	Sat.*	Average Mon.-Thurs.
Energy from	Cals.	2740	2475	2475	2220	270	2480
Carbohydrates	%	49	41	44	43		44
Energy from	Cals.	543	728	638	555	119	616
Proteins	%	10	12	11	11		11
Energy from	Cals	2293	2803	2523	2373	279	2498
Fats	%	41	47	45	46		45
Total Cals.		5576	6006	5636	5148	668	5594

*Light lunch only.

FOOD INTAKE OF 8 FOOTBALL PLAYERS, 2ND WEEK,—1934

		Tues.	Wed.	Thurs.	Fri.	Average Tues.-Fri.
Energy from	Cals.	2375	2405	2415	2195	2347
Carbohydrates	%	44	42	45	42	43
Energy from	Cals.	700	609	576	593	619
Proteins	%	13	11	11	11	12
Energy from	Cals.	2283	2653	2348	2508	2448
Fats	%	43	47	44	47	45
Total Cals.		5358	5667	5339	5296	5414

FOOD INTAKE OF 8 FOOTBALL PLAYERS, 5½ DAYS,—1933

	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.*	Average Mon.-Fri.
Total Cals	6076	5825	5711	5727	5643	1049	5796

*Light lunch only.

TABLE 3

HEIGHT AND WEIGHT OF 8 PLAYERS ON DIETARY RÉGIME

	Mon.	Tues.	Wed.	Thurs.	Fri.
Mean Weight, 1933, kg.	83.7	84.4	83.7	83.5	83.6
Mean weight, 1st period, 1934, kg.	79.5	80.0	79.5	79.5	80.1

	1933	1934
Mean height, cm.	186.5	183.0
Mean surface, m^2.	2.05	2.02

[5] Rubner, M., Zeitschr. f. Biol., 1902, xliii, 391.

[6] Lusk, G., Science, 1924, lix, 554.

small fraction of this can be considered as oxygen debt in the sense used by Hill and his associates[7]. When players leave the field, their blood lactate may be as high as 100 mg. per 100 cc. but according to the calculations of Margaria, Edwards, and Dill[8] this implies an oxygen debt of only eight or ten liters, equivalent to about four per cent of the 1,200-cals. excess. However, no matter what name is given to this excess oxygen consumption, it must be considered a consequence of strenuous activity. Benedict and Carpenter[9] studied this phenomenon. A summary of their results is shown in table 4.

TABLE 4

HEAT PRODUCED DURING SLEEP (1 A.M. TO 7 A.M.) FOLLOWING DIFFERENT CONDITIONS OF ACTIVITY, AS REPORTED BY BENEDICT AND CARPENTER*

(Average per hour.)

Subject	Sleep after rest	Sleep after moderate work	Sleep after severe work	Sleep after very severe work
	cals.	cals.	cals.	cals.
E. O.	69.3	74.8	—	—
J. F. S.	60.4	65.3	—	—
J. C. W.	77.2	—	83.1	—
B. F. D.	69.8	—	83.3	—
A. L. L.	78.3	—	83.7	97.9

*All work ceased at least 7 hours before metabolism measurements began except in the case of very severe work in which work ceased but 1 hour before.

The same phenomenon has been studied recently by Herxheimer, Wissing and Wolff[10]. They find that even forty-eight to seventy-two hours after severe work the metabolism may be ten per cent above normal. While they concluded that this increase is a consequence primarily of severe work, we find that even when the work is only seven times the resting metabolic rate, with no increase in lactic acid, there is a considerable increase in resting metabolism[11]. Apparently, the increase depends on quantity of work, i.e., it is a function not only of intensity of work, but of its duration also.

Table 5 contains measurements of the B.M.R. of three members of the Harvard team. They were studied shortly after being awakened on each of seven successive mornings following a game, and subsequently on the morning after the weekly game, and finally some weeks after the season was over. Their metabolism in this final study was high enough to suggest that in the above computations a value slightly higher than Rubner's[5] should have been employed. It is clear, however, that even fifteen hours after a game or a strenuous practice, as notably after the Thursday practice, the metabolic rate is in general distinctly elevated. Observations on subjects in this laboratory indicate that while lactic acid, alkaline reserve and other properties of the blood return to the resting level promptly, the metabolism after strenuous activity returns to normal asymptotically and slowly; the fact that it may be twenty-five per cent above normal after fifteen hours' recovery gives some clue to the elevation in earlier stages of recovery.

In lacrosse, a game similar in intensity and duration to American football, the metabolism was twenty-three per cent above its minimal value after thirteen hours and eight per cent after thirty-one hours.

The significance of these facts is twofold. The modern program of physical activity for the college student entails for many men, besides those on football teams, an unusually large caloric requirement. This means that any dietary régime based on the assumption that the college student is a sedentary person or even engaged in moderate activity is apt to be erroneous. Adequate allowance must be made for the wide range in requirement. The average requirement is meaningless; if it is supplied arbitrarily, the sedentary student will be surfeited

TABLE 5

RESTING METABOLISM AFTER FOOTBALL PLAYING

	Player B.		Player H.		Player G.	
	B.M.R.	Playing time min.	B.M.R.	Playing time min.	B.M.R.	Playing time min.
Brown, Sunday	—	25	+28	60	+25	60
Monday	+23		—		+ 7	
Tuesday	+19		+18		— 5	
Wednesday	+10		+13		—11	
Thursday	+14		— 4		— 5	
Friday	+19*		+16*		— 3*	
Saturday	— 2		+ 4		— 5	
Holy Cross, Sunday	+ 8	43	+20	33	+12	57
Dartmouth, Sunday	+34	42	+13	48	± 0	52
Princeton, Sunday	— 1	0	—		— 7	53
Army, Sunday	+ 9	17	—		+25	48
New Hamp., Sunday, Nov. 18	+22	16	+ 6	16	+ 5	30
January 15	+ 6		— 4		+ 5	

*Strenuous practice preceding afternoon.

and the student engaged in strenuous sport will go hungry.

The other point worthy of emphasis is that the increase in resting metabolism should be taken into account in calculating the dietary requirement of a given activity. It is a common practice to determine the oxygen intake during activity and neglect the fact that hours may elapse before metabolism has returned to normal. If this were applied to football players, we might estimate that the twenty-four hour requirement is 2,800 + (2 x 665) or 4,130 cal. Our results indicate that such a calculation would be in error by about 1,500 cals., since we have presented sufficient proof to establish 5,600 as the average caloric requirement of football players.

CONCLUSION

From this study of the diets, weights and metabolic rates of two groups of football players we conclude that:

1. The average energy requirement is 5,600 cals. per day.
2. Approximately twelve per cent of this requirement is provided by protein, forty-four per cent by carbohydrates and forty-four per cent by fat.
3. On the assumption of a metabolic rate of ten times the normal B.M.R., fifty per cent of the energy requirement of football playing remains to be accounted for after the game.
4. After physical activity has ceased the return to normal metabolism is slow and fifteen hours after activity the B.M.R. may be plus twenty-five.
5. This increased resting metabolism must be provided for.

REFERENCES

1. Woods, C. D., and Mansfield, E. H.: U. S. Dept. Agr. Bull. No. 149, 1904.
2. Bainbridge, F. A.: The Physiology of Muscular Exercise. Rewritten by A. V. Bock, and D. B. Dill. Third Edition. London: Longmans, Green & Company, 1931.
3. Joslin, Elliott P.: Diabetic Manual. Philadelphia: Lea & Febiger. 1929.
4. Bulletin 28. Office of Experimental Stations, U. S. Dept. Agr. April 14, 1906.
5. Rubner, M.: In von Leyden's "Handbuch der Ernährungstherapie". **1**: 153, 1903.
6. Lusk, G.: The Science of Nutrition. Fourth Edition. Philadelphia: W. B. Saunders Company, 1931.
7. Hill, A. V.; Long, C. N. H., and Lupton, H.: Effect of fatigue on relation between work and speed, in contraction of human arm muscles. Proc. Roy. Soc. B **97**: 84, 1924.
8. Margaria, R.; Edwards, H. T., and Dill, D. B.: The possible mechanisms of contracting and paying the oxygen debt and the rôle of lactic acid in muscular contraction. Am. J. Physiol. **106**: 689, 1933.
9. Benedict, F. G., and Carpenter, T. M.: The metabolism and energy transformation of healthy man during rest. Carnegie Institution of Washington. Publication 126, P. 103, 1910.
10. Herxheimer, H.; Wissing, E., and Wolff, E.: Spätwirkungen erschöpfender Muskelarbeit auf den Sauerstoffverbrauch. Ztschr. f. ges. Exper. Med. **51**: 916, 1926.
11. Dill, D. B.; Jones, B. F., and Edwards, H. T.: Le Travail Humain. **2**: 1, 1934.

MASSACHUSETTS DEPARTMENT OF HEALTH

Worcester Cancer Clinic

The Worcester Cancer Clinic of the Massachusetts Department of Health has been reorganized and its work concentrated at Memorial Hospital where excellent accommodations have been placed at its disposal by the trustees and Superintendent Stone.

Its staff has been augmented by representative specialists from all the hospitals. At least three specialists will be in attendance at each session of the clinic in order that patients referred may have the benefit of group diagnosis as prescribed by the American College of Surgeons. This is a purely diagnostic clinic. Each case will be sent back to the referring doctor or hospital with a full report as to diagnosis and treatment advised.

There are no charges for this service and it is open to all classes provided applicants are accompanied by their physicians or bring referring letters from their physicians, or from hospitals, or welfare organizations.

The clinics are held each Wednesday at 11 A.M. in the Out-Patient building at Memorial Hospital, Belmont Street, Worcester.

This clinic does not supersede or interfere in any way with the treatment clinics maintained by the hospitals and conducted under their rules, but supplements them by group diagnosis and social service.

It is hoped that physicians will avail themselves of the opportunity to observe cancer cases by being present at the clinics especially when presenting patients of their own.

Wm. F. Lynch, M.D., *Secretary and Treasurer.*

Organization

Chairman of Committee and Chief of Staff: Dr. Ernest L. Hunt.

Secretary-Treasurer of Committee and Staff: Dr. William F. Lynch.

Members of Committee and Clinic Supervisors: Dr. Edwin H. Trowbridge, Dr. Edgar A. Fisher, Dr. Michael F. Fallon, Dr. Royal P. Watkins, Dr. Benjamin H. Alton.

Attending Staff

Memorial Hospital: Dr. Walter C. Seelye, Surgeon; Dr. Richard Dresser, Radiologist; Dr. William J. Elliott, Pathologist, Radiologist; Dr. H. H. Serunian, Physician.

Worcester City Hospital: Dr. Frank L. Magune, Surgeon; Dr. Benjamin F. Andrews, Surgeon; Dr. Percy A. Brooke, Gastro-Enterologist; Dr. Raymond H. Goodale, Pathologist.

St. Vincent Hospital: Dr. John Fallon, Surgeon; Dr. James McCann, Surgeon; Dr. William Moran, Pathologist; Dr. A. F. O'Connell, Roentgenologist.

Hahnemann Hospital: Dr. A. W. Marsh, Surgeon; Dr. Philip H. Cook, Radiologist; Dr. William Freeman, Pathologist.

Fairlawn Hospital: Dr. Everett Jewett, Surgeon; Dr. A. Brassau, Surgeon.

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Office: Memorial Hospital, Belmont Street, Worcester.

Clinics: Wednesdays at 11 A.M.

Telephone: 4-2626 Extension 49.

CASE RECORDS
of the
MASSACHUSETTS GENERAL HOSPITAL

ANTE MORTEM AND POST MORTEM RECORDS AS USED IN WEEKLY CLINICAL-PATHOLOGIC EXERCISES

FOUNDED BY RICHARD C. CABOT, M.D.

TRACY B. MALLORY, M.D., *Editor*

CASE 21371

PRESENTATION OF CASE

A thirty-three year old American taxi driver entered complaining of pain in the left lower quadrant.

Approximately two months before entry the patient first developed a dull ache in the left lower quadrant, appearing usually upon standing and walking and relieved by lying down. The pain persisted and was relieved only when he went to bed. Upon defecation the pain radiated sharply around to the back and occasionally to the right. There was no relation of the pain to meals. About one week after the onset he noticed that his left testis had gradually become swollen and was often painful, especially when high in the scrotum. During the past month he had slight frequency during the day and nocturia. There was no dysuria or hematuria. His bowels were regular and there was no diarrhea. During the past month he noticed that the shape of his feces had been flatter. There had not been any tarry or clay colored stools and once after taking a cathartic he passed whole blood for one day. He attributed this blood to piles which he had had for at least six years. Occasionally he had a similar pain in the right lower quadrant, but this was mild and only transient. During this illness he had lost a good deal of his energy and ambition. He had lost about twelve pounds in weight. Two weeks before entry he noticed a small hard lump in the left lower quadrant. Recently it was pointed out to him at a clinic that this mass had grown in size.

His family history is non-contributory.

He had a Neisserian infection ten years before entry which was treated for about three months. Associated with this infection he had venereal warts. Three years later he had a second Neisserian infection which was followed by a chronic prostatitis. This was treated routinely twice a week for about six months.

Physical examination showed a well-developed, muscular man. The heart and lungs were negative. Just to the left of the midline in the lower quadrant was a large non-movable nodular mass, approximately 10 by 6 by 4 centimeters. The prostate was boggy. There was a left hydrocele.

The temperature was 99°, the pulse 78. The respirations were 20. Blood pressure was 114/74.

Laboratory examination of the urine was negative. The blood showed a red cell count of 5,510,000, with a hemoglobin of 80 per cent. The white cell count was 9,300, 76 per cent polymorphonuclears. The stools were soft, firm, blackish brown, and showed a 2 plus guaiac.

X-ray of the chest showed slight tenting of the left diaphragm in the region of the heart. A flat abdominal plate showed normal kidneys and no evidence of urinary calculi. A barium enema stopped abruptly after it had filled the rectum. The colon could not be filled beyond this point. It could not be determined whether or not the overlying soft tissue mass was intrinsic or extrinsic. An intravenous pyelogram was negative.

On the eighth day an exploratory laparotomy was performed.

He developed a few râles in the right base postoperatively. These, however, cleared up and he was discharged two weeks after operation.

He returned six days later because of marked cramps in the lower abdomen with distention. An ileostomy was performed under local anesthesia. Following operation he received fluids intravenously and was kept comfortable with opiates. He gradually went downhill and died on the eleventh postoperative day.

DIFFERENTIAL DIAGNOSIS

DR. GRANTLEY W. TAYLOR: Pain in the left lower quadrant is rather apt to be more obscure and due to more diverse causes than pain in the right lower quadrant. The history brings out one brief relationship to the gastrointestinal tract; namely, that on defecation he had radiation of pain to the back; and a definite implication of the genitourinary tract in that his testis was swollen and painful and he had slight frequency and nocturia. We want more data before we can decide which one of these tracts is primarily involved in the process. The character of bleeding from the rectum must be carefully gone into as one takes a history. I think in regard to a single bleeding episode one is perhaps justified in attaching less significance to it than if it were the usual thing. We might find that it is present especially after vigorous catharsis, sometimes in relation to trauma and sometimes in relation to piles. This bleeding episode may have no significance in the clinical picture as you see it now.

The loss in weight and energy is the first indication that this is more than a purely local process. It is severe enough to involve and affect the entire individual to some extent. The

presence of a mass is the first indication we have that there is any physical abnormality except for a swelling of his testicle which was referred to farther back.

We have a very definite past history episode which might conceivably enter into the picture along with the swollen testicle, pain, frequency, etc. It is worthwhile to pause for a minute and wonder if the whole picture, including the mass, could be accounted for by some complication of Neisserian infection and chronic prostatitis. Prostatitis due to Neisserian infection is very common but the number of times we see an abdominal mass associated with it is so infrequent as to be a rarity. I have never heard of it.

The history states that the mass has grown very rapidly to a rather large size. A mass of this sort you would like to be able to feel for yourself to know if it had been entirely discrete from true pelvis or whether it was barely sticking out that much from below. Whether a mass of that sort is fluctuant or hard is of considerable significance in the diagnosis. We know that it is fixed and nodular. If you had a suppurative process or an infectious process reaching that size in that space of time it seems to me it would be reasonable to look for some evidence of fluctuation. You might also find some evidence of fluctuation in a neoplastic mass that had grown to that size.

Those evidences which we have had pointing toward the urological tract; to wit, the painful testicle which was swollen, the hydrocele, and the slight change in urinary habits, do not necessarily mean that the primary process originated in that tract. You can have disturbances of the urinary tract of that sort from extrinsic tumors which impinge on the nerve or blood supply or lymphatic return from the region of the testicle. Hydrocele is very commonly associated with inflammatory or neoplastic processes in or about the inguinal region or in the pelvis in deep relationship to the drainage from these areas; so although the symptoms require that we investigate with some care, it does not necessarily mean we will find primary trouble in that region. The temperature of 99°, the normal pulse and the white count of 9,300, with 76 per cent polymorphonuclears are the only data which will bear on the presence or absence of a primary inflammatory process. It seems to me there is no very good ground for suspecting sepsis. It does not mean, however, that it cannot be present. A chronic inflammatory process occasionally gives rise to very little in the way of reaction in the chart, especially long standing tuberculosis or long standing abscess of any cause. On the other hand we have the patient's story to the effect that this has been a rapid development, and it seems to me any inflammatory process as rapid as that would still be giving rise to considerable variations in the chart and influencing the leucocyte count more than it is. The possible exception might be tuberculosis.

The stools were soft, firm, blackish-brown and showed a two plus guaiac which would be in keeping with a lesion in the gastrointestinal tract, but on one observation a positive guaiac is not very significant, especially if the patient is not on a restricted diet. It would be consistent with the history of bleeding. We should like to know whether there were hemorrhoids present and also some statement as to the character of the rectum in so far as it was subjected to examination by the finger. We will assume that it was negative or they would have commented on it. In connection with the possibility of chronic piles or bleeding of any significance in the gastrointestinal tract, we must consider the high red count which certainly means the patient has not had chronic blood loss or any acute blood loss within recent times.

It is hard to know why a chest x-ray was taken unless the condition was considered tuberculosis and they were looking for confirmation of tuberculosis elsewhere in the body. Tenting of the diaphragm does not mean very much to me.

X-ray Interpretation

Dr. George W. Holmes: As Dr. Taylor has suggested, this is the so-called tenting of the diaphragm. Sometimes, at least, these changes are due to adhesions between the diaphragm and pleura at the base of the lung, they are sometimes due to localized areas of atelectasis in the lung, sometimes unexplained. I do not think they are of any clinical importance in this case. His lungs are unusually clear. As Dr. Taylor suggested, it is possible that the film was taken to rule out tuberculosis but I think it more likely that the observer had in mind the possibility of malignancy in the lung and wanted to be sure there were no metastases in the lung or mediastinum. The heart is normal in size and shape and there is no evidence of changes in the aorta. You can see the fairly well filled ureters and a small amount of dye in the bladder. This shadow is well outside the ureter and is probably a calcified gland. It is on the right side. The tumor mass that was felt was on the left side. I presume that the patient was unable to retain the enema and that the obstruction was so low that the enema was expelled before the examiner had an opportunity to take a film.

Differential Diagnosis Continued

Dr. Taylor: This x-ray information gives us definitely more data and tends to exempt the urinary tract as a primary focus for the process. It would be a very large tumor indeed which would give rise to obstruction high in the rectum and at the same time be felt above Poupart's

ligament, and there should be some connection between the two. We have definite stoppage of the colon between the rectum and the sigmoid. The x-ray could not determine whether it was intrinsic or extrinsic. The x-ray also points out that we are not dealing with a bone tumor in that region.

We are left with a tumor in the lower abdomen and a lesion that has caused some loss of weight, strength, etc., and it seems to me we have to make up our minds what it is. It is hard to know without further data. We should like certainly to have a proctoscopic examination. It seems to me that at proctoscopy one would have been confronted with a wall of perfectly normal, smooth, rectal mucosa, with some trouble in deciding whether the bowel lumen passed behind that wall, and whether right or left or anterior to it. Certainly there is nothing characteristic of primary new growth in the rectum or rectosigmoid region, in spite of the few things pointing in that direction. Let us consider again the possibility of an inflammatory process. Diverticulitis and that sort of thing we cannot rule in or out. Certainly the history does not disclose anything to make us think that that is the right diagnosis. Primary neoplasm, retroperitoneal sarcoma, is a kind of catch all. A tremendous number of tumors appear in that region—lymphomas, chordomas or sarcomas. We see a certain number of metastatic tumors in the pelvis from primary foci which are silent but which may give infiltration of the lymph nodes or direct tumor extension. It is possible that something of the sort is responsible for this picture. It seems to me the significant thing is the very rapid growth that the lesion has had and the relative freedom from localizing symptoms, so I should say retroperitoneal malignant tumor, possibly lymphoma, was the best bet.

The patient was explored on the eighth day. I do not know what was done. It would seem as long as there was obstruction of the colon by x-ray it might have been considered desirable to do a colostomy at that time. Certainly exploration would shed more light, but on exploration I suspect a definite diagnosis could not be arrived at unless a biopsy was removed. Undoubtedly any abdominal organs passing into the pelvis went into a dense matted mass the nature of which was obscure to the surgeon. He might or might not have removed a specimen for pathologic examination and closed the abdomen.

The ileostomy was done presumably as an emergency measure. It is interesting that his obstruction required an ileostomy rather than a colostomy. You would suppose that obstruction would be at the place pointed out by x-ray. But under novocain you take what you can and put a catheter in.

As regards the immediate cause of death in this case, we do not know but it seems unlikely that the tumor has progressed so rapidly as to cause demise. Whether he had peritonitis, whether he had ileus or dehydration, you cannot tell. I should feel that if I saw this case clinically I would not be any clearer as to diagnosis until I had seen the autopsy. I should place my bet on malignancy in the pelvis, rapidly growing, and await the pathologist to tell us the findings.

DR. TRACY B. MALLORY: Dr. Leland, you saw the patient on the wards. Have you anything to add?

DR. GEORGE A. LELAND, JR.: I saw this patient prior to both of his operations but did not operate upon him. Anybody seeing a patient in vivo certainly has an advantage over the man who tries to make the diagnosis from a sheet of paper. As one looked at this man, the likelihood of inflammatory disease did not strike one as being very probable. The mass was hard, quite completely fixed, and in a very bizarre situation. Tests were undertaken as indicated to determine as far as possible its origin, whether the urological system or the gastrointestinal tract. It was felt that any preoperative diagnosis was chiefly of academic interest because it was quite apparent that it must be some malignant condition. Exploration was undertaken with the hope of ascertaining whether or not the malignant condition might be amenable to palliation from x-ray therapy. In the Outpatient Department a diagnosis of retroperitoneal lymphosarcoma had been made. Further studies in the ward did not advance us any farther and he was explored with that preoperative diagnosis.

CLINICAL DIAGNOSES

Preoperative: Retroperitoneal sarcoma.
Postoperative: Carcinomatosis.

DR. GRANTLEY W. TAYLOR'S DIAGNOSES

Malignant tumor of pelvis.
Retroperitoneal sarcoma?

ANATOMIC DIAGNOSES

Colloid adenocarcinoma of sigmoid with multiple peritoneal metastases.
Pulmonary edema, bilateral.
Esophagitis, acute.
Hydrothorax, bilateral.
Cholesterosis of gall bladder.
Multiple ulcers of small intestine.
Septicemia, hemolytic streptococcus.

PATHOLOGIC DISCUSSION

DR. MALLORY: Dr. Rogers did the exploration and found the pelvis and lower abdomen completely filled with an irregular mass of malignant tissue apparently arising from the left

posterior wall but he was unable to localize it any more accurately than that. He was still completely in the dark as to the primary source of the tumor. A piece of tumor was excised and showed colloid adenocarcinoma.

His second operation, of course, was for intestinal obstruction and although the patient died a very short time after that, within the short interval between the time of the first operation and death this malignancy had spread throughout the abdominal cavity so that the entire omentum and almost every structure in the cavity was a mass of gelatinous colloid material. The rate at which colloid carcinomas sometimes extend once they begin to grow freely in the abdominal cavity is almost incredible. Following the ileostomy a localized peritonitis had developed and I think was probably the immediate cause of death.

DR. TAYLOR: Did you find the source of the carcinoma?

DR. MALLORY: It was at the rectosigmoid junction, a very small portion only lying within the lumen of the bowel, not more than two centimeters in diameter. The vast majority of the tumor was lying almost free in the peritoneal cavity.

A PHYSICIAN: It was ulcerated and he was bleeding from it?

DR. MALLORY: Slightly; yes.

CASE 21372

PRESENTATION OF CASE

A fifty-one year old divorced Canadian practical nurse entered complaining of sore throat of two weeks' duration.

The patient had been working on a case doing twenty-four hour duty for five weeks. Two weeks before entry she developed a sore throat near the left tonsil. This was associated with pain on swallowing. A physician swabbed the throat with phenol and glycerin. She became very tired and the condition in her throat grew worse. On the fourth day she went to bed, where she stayed for two days. Two days later a physician incised her throat to allow for free drainage. During the week before admission she was very feverish and chilly, although she had no definite chills. She developed a constant headache and vomited once. The throat became very sore and she was able to take only liquid foods. Six days before admission she applied a hot water bag to her neck which resulted in a slight burn. On the evening before entry she took six allonal tablets.

Her father died of Bright's disease. Her mother and seven siblings were living and well.

She was married at sixteen and divorced at twenty-one. She had one child who died at the age of six months. There were no miscarriages.

She had measles as a child and diphtheria at the ages of twenty-five and twenty-eight. (*sic*) At the time of the birth of her child she developed peritonitis. For a period of fifteen years preceding the past fifteen years she had attacks of tonsillitis every spring. She had never had attacks similar to the present illness.

Physical examination showed a fairly well developed and nourished woman apparently drugged but fairly well oriented. The skin was sallow. The cheeks were flushed. The pupils were contracted and reacted very slightly. Examination of the throat showed a large area of gray ulceration with a sharply demarcated non-inflammatory border over the left tonsil. Smaller and similar areas were present above the uvula and on the anterior pillar. The breath was foul. There were a few moist râles at both bases. The abdomen was slightly distended and tympanitic.

The temperature was 101.2°, the pulse 100. The respirations were 22.

Examination of the urine showed a specific gravity of 1.016 to 1.020 with a slight trace of albumin and a brown test for sugar. The sediment was not remarkable. The blood showed a red cell count of 3,480,000, with a hemoglobin of 60 per cent, and a white cell count of 650. The smear showed 94 per cent lymphocytes and 6 per cent large mononuclears. There were no polymorphonuclears. The platelets were normal. Examination of the stools was negative. A smear of the left tonsillar region showed Vincent's spirochetes. The Hinton test was negative. The nonprotein nitrogen of the blood was 38 milligrams.

She was given intravenous glucose and several injections of pentnucleotide intramuscularly. Blood examinations on the second and third days showed white cell counts of 1,150 and 1,500 respectively. Both smears showed one hundred per cent lymphocytes. She failed very rapidly. The temperature rose steadily to 106°, she became irrational, developed an early cellulitis of the left arm, and died on the third day.

DIFFERENTIAL DIAGNOSIS

DR. F. DENNETTE ADAMS: The history in this case indicates that one is dealing with something more serious than ordinary sore throat. During the first few days there was apparently nothing to distinguish it from the usual case of acute tonsillitis and pharyngitis, but with this type of infection the patient should have been getting better, not progressively worse, at the end of a week. The record fails to indicate whether pus was obtained from incising the area. If we could be sure it was not, we would have an important diagnostic point. It is not uncommon in cases of agranulocytosis, even before the appearance of definite ulceration, for the throat to develop edema sufficient to be confused with the swelling of peritonsillar abscess.

The fact that the patient took six allonal tablets during the night before admission causes one to speculate as to whether she might not have had similar medication earlier in the disease. It is tempting to assume that being a nurse and consequently familiar with drugs, being tired and sick, she might well have tried to combat fatigue, insomnia and infection with this drug during the earlier stages. Allonal contains amidopyrin, which is considered by many to be a dangerous drug. It is generally agreed that in certain individuals who appear to have a particular susceptibility there is a relationship between its use and the development of agranulocytosis.

Diphtheria at twenty-five with a second attack at twenty-eight is quite possible, particularly in a nurse.

The areas of ulceration in the throat are consistent with agranulocytosis. The description does not suggest diphtheria; Vincent's angina is possible, but the patient was sicker than one would expect if only this disease were present. The râles in the chest could be simple congestion or the earliest sign of developing bronchopneumonia.

The blood count with practically total elimination of the granulocytic elements is typical of agranulocytosis. The presence of spirochetes of the Vincent type is not surprising. They are found in any type of ulcerative lesion in the mouth but not customarily in so great numbers as in the case of true Vincent's angina, where myriads are found in any smear, provided it is taken not from the surface slough but from the deeper and more active part of the lesion.

The blood culture is not reported. Septicemia might or might not be present.

The abscess on the arm is not localized in our summary. With no added information we might surmise that it came from glucose leaking into the tissues around the vein at the point of injection or from a hypodermic injection in a patient obviously lacking any resistance to infection. Failure to respond to nucleotide might be explainable on the basis of severity of the disease and the late stage at which it was administered, but opinion as to its efficacy in all cases, even if treated early, is not uniform.

The evidence in this case of acute sore throat with ulceration, marked prostration, and rapid downhill course, taken into consideration with the history of allonal ingestion, the physical findings and the blood count, is overwhelmingly in favor of agranulocytosis. Septicemia or bronchopneumonia, or both, may be present. The relationship between the disease and the use of drug containing amidopyrin cannot be stated definitely, but there is evidence sufficient to make one suspect that the drug may have been an important etiologic factor.

A PHYSICIAN: Are you satisfied as to the throat cultures and examination?

DR. ADAMS: By that do you mean they should have been studied for diphtheria? The type of lesion described is certainly not a typical picture of diphtheria. Cultures for diphtheria must have been taken. It is, I believe, a routine procedure on acute throat cases in this hospital.

A PHYSICIAN: What about blood stream infection? Is there a possibility of that?

DR. ADAMS: General septicemia? Most of these patients show no positive blood cultures but some do become positive in the late stages.

DR. TRACY B. MALLORY: A good many of them do, in my experience, though it is hard to say how large a proportion. Probably twenty-five per cent show positive cultures. Especially in the earlier cases reported several years ago there was a striking frequency of positive blood cultures with organisms ordinarily considered non-pathogenic, such as staphylococcus albus and bacillus pyocyaneus.

A PHYSICIAN: How often do you find it with Vincent's?

DR. MALLORY: A large proportion of the cases will show Vincent's organisms in the throat.

We never did get an accurate past history in this case and we do not know how long she had been taking allonal, but I should think the deduction reasonable that one who takes six pills must be familiar with the drug. I cannot imagine anybody swallowing that many who had never taken them before. Habituation to this particular group of drugs is an extraordinarily common thing in the nursing profession, also in the medical profession and the families of medical men. Dr. Hunter, who has just finished a very careful review of the literature on agranulocytosis, found, as other people have, that an overwhelming proportion, more than three fourths of the cases, have been in nurses, doctors and doctors' families. It is peculiarly a disease of the medical profession and closely related individuals. There is also a notable difference in the number of cases in different countries. Germany and America have provided the greatest number of cases; England and France, where coal tar drugs are less popular, many fewer.

CLINICAL DIAGNOSES

Agranulocytic angina.
Aleukemic leukemia?
Septicemia.

DR. F. DENNETTE ADAMS'S DIAGNOSES

Agranulocytosis.
Septicemia, terminal?
Bronchopneumonia, terminal?

ANATOMIC DIAGNOSES

Agranulocytic angina.
Septicemia with lymphangitis of left arm.
Ulcerative stomatitis.
Esophagitis, acute.

Bronchopneumonia, early.
Endocarditis, acute, mitral.
Hydropericardium.
Arteriosclerosis: Aortic and coronary, slight.
Chronic salpingitis.
Leiomyomata uteri.

Pathologic Discussion

Dr. Mallory: The autopsy on this patient was fairly typical of this disease. There was a terminal pulmonary infection which showed histologically fibrin, serous exudate and red cells —everything characteristic of pneumonia except leukocytes. A rather unusual finding was an ulcer in the esophagus which was very peculiar in appearance. On its surface were a lot of bright yellow granules, one millimeter to two millimeters in size, which looked like colonies of staphylococcus aureus on a blood agar plate. That in fact was what they were. Each little granule was a colony of millions of bacteria around which there was no leucocytic response at all. They were growing exactly as they do on favorable culture media.

She had an ulcer in the stomach as well which was interesting histologically for, whereas the vast majority of stomach ulcers are entirely free from bacteria, this ulcer showed a thick layer of bacteria all the way around it.

A Physician: This was not a chronic ulcer?

Dr. Mallory: No, a very acute one.

A Physician: Was it something that developed during the course of the disease?

Dr. Mallory: We think so.

A Physician: Were these organisms spirochetes?

Dr. Mallory: No.

The bone marrow in these people presents extremely variable pictures. There are three types that I have seen. You sometimes see people dying of an acute infection with a white cell count down to 1,000 or lower, few or no polymorphonuclears in the smear, and at autopsy you find a bone marrow that is totally lacking in granulocytes but with red cell formation going on in a normal fashion. Those cases have always had, in my experience, an infection, generally a septicemia, with an organism of high virulence, such as a hemolytic streptococcus. Dr. Jackson rules that group out and says that they are not true agranulocytosis. The leukopenia is to be regarded as secondary to a toxemia. The more typical cases, where the lesions tend to remain superficial and the organisms are of only average or low virulence, in whom you can often get a history of several recurrences of the disease and in whom we so frequently in the last two years have obtained a history of the ingestion of amidopyrin, show quite a different picture. In them the bone marrow is swarming with immature stem cells and it would be a fairly easy thing to mistake the section for one of leukemia. In fact, I am very sure that has often been done in the past. This type of case Dr. Jackson likes to compare with the bone marrow picture in pernicious anemia where red cells are being formed in more than sufficient numbers but they are not being matured to the point where they can be delivered into circulation and be useful. In true agranulocytosis the white cells are not being matured, most of them remain as stem cells, a few became myelocytes, practically none differentiate to leukocytes.

In patients that have run a somewhat longer course—this woman was in the hospital three days and had been sick for nearly two weeks, so that as cases go we can say she had reached the chronic stage—one often finds the bone marrow loaded with plasma cells. They may be so numerous that the sections may raise a question of a diagnosis of multiple myeloma. Such a picture is rarely seen in cases dying within the first four or five days of the disease but becomes common in those lasting seven days or longer.

A Physician: What is the feeling here about the use of liver extract in treatment?

Dr. Mallory: None of us here can see any logic in it.

A Physician: Why would not a transfusion have helped her?

Dr. Mallory: The local experience here has been that transfusions do not help. We have seen a number of bad reactions and no good results. It has become a matter of policy not to use them. It is only fair to admit, however, that any one person can see only a small number of these cases and hence is hardly justified in coming to a dogmatic conclusion. That just happens to have been our experience here.

The New England
Journal of Medicine

SUCCESSOR TO
THE BOSTON MEDICAL AND SURGICAL JOURNAL

Established in 1828

Published by THE MASSACHUSETTS MEDICAL SOCIETY under the jurisdiction of the

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SUBSCRIPTION TERMS: *$6.00 per year in advance, postage paid for the United States, Canada $7.04 per year, $8.52 per year for all foreign countries belonging to the Postal Union.*

Material for early publication should be received not later than noon on Saturday. Orders for reprints must be sent to the Journal office, 8 Fenway.

The Journal does not hold itself responsible for statements made by any contributor.

Communications should be addressed to The New England Journal of Medicine, 8 Fenway, Boston, Mass.

LEAD THERAPY OF CANCER

THE *New York Times*, under date of August 21, 1935, reports an attempt to revive the long-quiescent use of lead in the treatment of cancer. The paper was read by a group from the Mayo Clinic before the American Chemical Society. It is certainly unfair to say that the excellent facilities for publicity afforded by the presentation of a paper before such a gathering had anything to do with the choice of audience. But it is unfortunate to present material of interest to thousands of sufferers before a group which, by virtue of divergent interests and training, is incapable of thoroughly criticizing and evaluating it.

Whereas material of primarily chemical nature is properly treated before a group of chemists, a paper which apparently emphasizes chiefly the results of therapy, particularly in such a disease as cancer, seems definitely out of place. In this instance presentation before a group interested and experienced in cancer treatment would be far more valuable.

As far as one can judge from the quotation in the newspaper seven cases of eighty-five, all inoperable, improved with lead treatment alone. The investigators do bring out the fact, established years ago, that unless lead therapy is pushed to the point of toxic symptoms, little in therapeutic results may be expected.

Following Blair Bell's initial announcement, some ten years ago, lead therapy was taken up in various centers and carefully scrutinized. Little value, however, has been derived from the use of this form of treatment in the past. When one considers the dangerous and painful effects of acute lead poisoning, considerable hesitancy is indicated before using such an uncertainly helpful and surely dangerous substance.

It is indeed to be regretted that such widespread publicity has attended a report which encourages the wider use of lead compounds in cancer therapy. If and when details of the procedures of Osterberg, Bargen, and Horton are presented before medical groups or published in periodicals seen by physicians it may be possible to evaluate the importance of their contribution. We all hope they have made a step forward in the struggle against the disease. For the present, at least, the general reluctance to use lead compounds in treating cancer should continue.

THE INTERN AND INSURANCE

RECENT reports are to the effect that the Interne Council of Greater New York has sought legislative action to provide for interns appropriate compensation and proper "insurance protection in case of mishap, disability or death suffered in line of duty". The movement has been characterized as an enlightened protest against the exploitation of the intern and is to be taken as another sign of the growing self-consciousness of this group of young physicians. The implication is that because they are hospital employees the cost of such insurance should be borne by the institution. Thus the burdens of the hospital administrator are becoming more onerous almost daily, but there is here a problem that deserves most careful and thorough study.

Again, the legal status of the activities of the intern is not always clear. Is he practicing medicine? Is he licensed so to do? Is he subject in every way to the provisions of the medical practice act? Is he responsible as any other physician in all civil matters involving his profession and in all the laws of the state pertaining to the practice of medicine, including malpractice?

That the intern is substantially practicing medicine is clear. Whether he does so in the legal sense is not always so clear. Physicians may and do delegate to unlicensed persons certain tasks which otherwise the physicians themselves would perform. Which of these tasks are the practice of medicine? It is because there were delegated to interns many duties, performed in the absence of the registered physician and involving the assuming of certain responsibility by the intern, that it was thought best in Massachusetts to protect hospitals and medical staffs and interns by specific license of this third group.

The restrictions under the statute are as follows: "But such limited registration (as intern) shall entitle the said applicant to practice medicine only in the hospital or other institution designated on his certificate of limited registration, or outside such hospital or other institution for treatment, under the supervision of one of its medical officers who is a duly registered physician, of persons accepted by it as patients, and in either case under the regulations established by such hospital or other institution."

Under the license he is subject to every provision of the medical practice act, and all the laws of the Commonwealth pertaining to the practice of medicine, including malpractice.

But he is an officer of the hospital and an employee and certain of his acts are in this capacity. For example, he does not need an individual narcotic permit if the hospital is duly registered under the narcotic regulations. As an officer of a charitable institution he is protected against certain claims by law. What protection has he if he is dealing with a patient who is not a charity patient?

His position differs, however, from that of the physician not an intern in that he is in part an agent and may be called upon to perform acts on which he is not competent to pass judgment medically: the visiting physician has left an order which he carries out to the best of his ability. Some sort of disaster occurs and suit is brought against him for malpractice.

Should the intern be protected by insurance? Should the hospital or the medical staff or the intern pay for such insurance? The answer will depend in part on the laws of the state. However, this should be kept in mind. Insurance against malpractice suits is one of the most certain ways to stimulate such suits. The purpose of these suits generally is to obtain a financial salve for a real or imaginary harmful result of the action of the agent. If the agent has no money, he cannot pay money and suit is not likely. If it is generally known that a wealthy insurance company is back of the intern, a lawsuit may be an appealingly easy way to get some of the company's money. Certainly suits for malpractice have enormously increased since insurance companies have entered the field in defending physicians and paying damages.

The value of such an organization as has been set up in New York will depend on what it does. It is capable of much good, it is capable of much harm. *Pessima corruptio optimae.* It may be that interns in seeking protection would expose themselves to a greater evil.

BOSTON HEALTH LEAGUE

Activities of the Past Year

The activities of the Boston Health League in promoting better health conditions in Boston during the past year were summarized by the reports of its various committees at the annual meeting of the Corporation late in May.

The health education committee has approved the formation of an Advisory Committee on Health Education for the City Health Department.

Mention has previously been made of the republishing and revising of the bulletin of the Summer Camp Committee. Over four hundred of these bulletins have been distributed. The Educational Committee on Cancer has as usual been very active, distributing much literature and arranging for educational talks on cancer. A social study of cases in each of the seven cancer clinics is now in progress.

The Committee on Social Hygiene has continued to sponsor the staff council on syphilis and gonorrhea and the consultation service of the Massachusetts Society for Social Hygiene. It is coöperating with the Massachusetts Society in the Boston aspects of a study of social hygiene instruction in the educational system.

Domiciliary medical care has been under considerable discussion during the past year, and the Committee on Techniques and Standards has recommended that a continuing committee on Domiciliary Medical Care for the Sick Poor of the City of Boston be organized as an integral part of the newly formed Hospital Council of Boston.

The Committee on the Needs of Ward Nine, where health conditions among the Negro population have been so unsatisfactory, sponsored an exhibit on nutrition in the fall; the Committee on Pneumonia has continued its efforts to reduce mortality from lobar pneumonia by urging prompt nursing care, and calling attention to the fact that the Community Health Association gives nursing service on a visit basis to persons not needing or unable to afford a full-time nurse.

It is apparent that the Boston Health League is continuing to fulfill the important functions for which it was formed; to advise, to educate and to coördinate.

THIS WEEK'S ISSUE

CONTAINS articles by the following named authors:

CHAFFEE, E. L. S.B., A.M., Ph.D. Gordon McKay Professor of Physics and Communication Engineering, Harvard University. His subject is "The Physics of High-Frequency Currents as Used in Medicine—Diathermy, Radiothermy and the Electric Knife." Page 505. Address: 130 Goden Street, Belmont, Mass.

BIERMAN, WILLIAM. M.D. Columbia University College of Physicians and Surgeons 1917. Attending Physical Therapist, Mt. Sinai Hospital, New York, and Sydenham Hospital, New York. Lecturer, Physical Therapy, Department of Therapeutics, New York University Medical School. Instructor in Surgery (Physical Therapy) Columbia University, New York. Address: 471 Park Avenue, New York City. Associated with him is

SCHWARZSCHILD, MYRON. B.A., M.A. Physicist, Beth Israel Hospital, New York. Address: Beth Israel Hospital, New York City. Their subject is "The Therapeutic Use of Short Wave Currents." Page 509.

CARTY, JOHN R. B.S., M.D. Cornell University Medical College 1921. Associate Professor of Radiology, Cornell University Medical College. Radiologist-in-Chief, New York Hospital. His subject is "Diagnostic Possibilities in Soft Tissue Radiography." Page 517. Address: New York Hospital, 525 East 68th Street, New York City.

REGAN, JAMES J. M.D. Tufts College Medical School 1913. Ophthalmic Surgeon-in-Chief, Boston City Hospital. School Physician assigned to Ophthalmology, Boston Public Schools. Assistant Professor of Ophthalmology, Tufts College Medical School. His subject is "Routine Vision Testing of School Children; A Plea for Standardization." Page 519. Address: 520 Commonwealth Avenue, Boston.

BOOS, WILLIAM F. A.B., Ph.D., M.D. Harvard University Medical School 1901. Former Instructor in Chemistry, Harvard University, and Assistant in Hygiene, Harvard University Medical School. Now, Toxicologist for State of Massachusetts and other States, and Lecturer on Toxicology, Harvard University Medical School. Address: 196 Beacon Street, Boston. Associated with him is

WERBY, A. BENJAMIN. B.S., Massachusetts Institute of Technology 1911. Chemist, Research Laboratories, New York and Boston. Address: 88 Broad Street, Boston. Their subject is "Arsenic in Human Tissues and Food Animals. I. So-Called Normal Arsenic." Page 520.

SPINK, WESLEY W. A.B., M.D. Harvard University Medical School 1932. Assistant Resident Physician, Thorndike Memorial Laboratory, Boston City Hospital. Assistant in Medicine, Harvard University Medical School. Address: Thorndike Memorial Laboratory, Boston City Hospital, Boston. Associated with him is

AUGUSTINE, DONALD L. Sc.D. Johns Hopkins School of Hygiene and Public Health 1923. Assistant Professor of Helminthology, Harvard University Medical School. Address: Harvard University Medical School, Boston. Their subject is "Trichinosis in Boston." Page 527.

MORRISON, HYMAN. A.B., M.D. Harvard University Medical School 1908. Professor in Clinical Medicine, Tufts College Medical School. Visiting Physician, Beth Israel Hospital. His subject is "Trichiniasis Among Jews." Page 531. Address: 483 Beacon Street, Boston.

EDWARDS, H. T. A.A. Harvard University 1927. Assistant, Fatigue Laboratory. Address: Fatigue Laboratory, Morgan Hall, School of Business Administration, Harvard University Medical School, Boston. Associated with him is

THORNDIKE, A., JR. M.D. Harvard University Medical School 1921. F.A.C.S. Surgeon, Department of Hygiene, Harvard University Medical School. Assistant in Surgery, Harvard University Medical School. Associate Surgeon, Children's Hospital, Boston; Milton Hospital, Milton; and New England Baptist Hospital, Boston. Consulting Surgeon, Massachusetts Hospital School, Canton. Address: 319 Longwood Avenue, Boston. Associated with him is

DILL, D. B. Ph.D. Stanford University 1925. Assistant Professor of Biological Chemistry, Harvard University Medical School. Address: Fatigue Laboratory, Morgan Hall, Soldiers Field Station, Boston. Their subject is "The Energy Requirement in Strenuous Muscular Exercise." Page 532.

MISCELLANY

SCREW WORM LOSSES CHECKED IN THE SOUTHEASTERN STATES

The screw worm made practically no gains in the Southeastern States during August. But the lull in its activity that occurs about the first of September if the weather is hot and dry does not mean the pest has quit for the season, says Dr. F. C. Bishopp of the Bureau of Entomology and Plant Quarantine. When the weather is cooler and more rain falls, the screw worm flies will be back with renewed energy. They will remain aggressive until low temperatures of late fall or early winter drive them to hibernate.

Recent reports to Doctor Bishopp, who is in charge of the control campaign financed with a special appropriation of $480,000, refer especially to infestation of animals.

Screw worm cases among human beings are not

uncommon in many parts of the South. Twenty-five such cases have been reported during the present season. People with exposed sores or wounds, Doctor Bishopp says, take a long chance when they sleep out in the open with no protection against the screw worm fly. The screw-shaped worms that hatch from the eggs laid by the adult flies can soon turn a tiny scratch into a large, deep wound. Sometimes the flies lay their eggs in the nasal passages of people suffering from catarrh or a nose injury. Swelling and soreness always accompany the activity of the worms that hatch from these eggs. The swelling or soreness of the nose of a person who has been exposed to fly attack is a signal to seek competent medical advice. These small, burrowing worms have been known to destroy the bridge of a person's nose.—Excerpt from the *Bulletin of the Department of Agriculture.*

ANTERIOR POLIOMYELITIS CASES FOR 1935

WEEKLY LIST

City or Town	January-May	June	July	August	September 3-7	Total to Date for Year
Attleboro	0	0	0	1	2	3
Brewster	0	0	0	2	0	2
Fall River	0	0	6	66	15	87
Falmouth	0	0	0	1	0	1
New Bedford	0	0	0	4	1	5
Plymouth	0	0	0	1	0	1
Somerset	0	0	0	3	1	4
Swansea	0	0	0	1	1	2
Taunton	0	0	0	0	1	1
Truro	0	0	0	1	0	1
Wareham	0	0	0	1	0	1
Westport	0	0	0	3	0	3
Braintree	0	0	0	1	2	3
Brockton	0	0	0	5	0	5
Dedham	0	0	0	2	0	2
East Bridgewater	0	0	0	0	1	1
Hopkinton	0	0	0	1	0	1
Millis	0	0	0	1	0	1
Milton	0	0	0	0	1	1
Natick	0	0	0	0	1	1
Norwood	0	0	0	0	2	2
Quincy	0	0	0	4	1	5
Scituate	0	0	0	4	1	5
Stoughton	0	0	0	0	1	1
Weymouth	1	0	1	2	1	5
Arlington	0	0	0	2	2	4
Belmont	0	0	0	2	1	3
Boston	0	1	19	176	46	242
Brookline	0	0	0	2	1	3
Cambridge	1	0	1	18	14	34
Chelsea	0	0	0	11	3	14
Concord	0	0	0	1	0	1
Everett	0	1	1	9	2	13
Lexington	0	0	0	1	0	1
Malden	1	0	0	5	4	10
Medford	0	0	0	8	2	10
Melrose	0	0	0	3	2	5
Newton	0	0	0	3	3	6
Revere	0	0	0	2	4	6
Somerville	0	0	0	11	4	15
Waltham	1	0	2	9	6	18
Watertown	0	0	1	7	1	9
Wellesley	0	0	0	0	1	1
Winthrop	0	0	0	5	0	5

City or Town	January-May	June	July	August	September 3-7	Total to Date for Year
Amesbury	0	0	0	3	0	3
Andover	0	0	1	1	1	3
Beverly	0	0	1	11	0	12
Billerica	0	0	0	3	1	4
Danvers	0	0	0	2	0	2
Dracut	0	0	0	0	4	4
Gloucester	1	0	0	3	0	4
Hamilton	0	0	0	0	1	1
Haverhill	0	0	1	18	6	25
Ipswich	0	0	0	3	0	3
Lawrence	0	1	3	1	1	6
Lowell	0	0	3	16	6	25
Lynn	0	0	2	5	2	9
Manchester	0	1	0	2	0	3
Marblehead	0	0	1	0	0	1
Methuen	0	0	0	0	1	1
Middleton	0	0	0	1	0	1
Newburyport	0	0	0	3	2	5
North Andover	0	0	0	4	0	4
Peabody	0	0	0	1	0	1
Salem	0	0	0	1	0	1
Saugus	0	0	0	2	0	2
Swampscott	0	1	0	1	0	2
Wakefield	0	0	0	1	0	1
Westford	0	0	0	1	0	1
Woburn	0	0	0	0	1	1
Blackstone	0	0	0	1	0	1
Fitchburg	0	0	0	6	3	9
Marlboro	0	0	0	1	0	1
Milford	0	0	0	0	1	1
Millbury	1	0	0	0	0	1
Northbridge	0	0	0	1	0	1
Shrewsbury	2	0	0	0	0	2
Templeton	0	0	0	1	0	1
Uxbridge	0	0	0	3	0	3
Westboro	0	0	0	2	0	2
Worcester	0	0	1	4	2	7
Chicopee	0	1	0	0	0	1
Ludlow	0	0	0	0	1	1
Northampton	0	0	1	0	0	1
South Hadley	0	0	0	0	1	1
Springfield	0	0	1	2	6	9
Greenfield	0	0	0	1	0	1
Pittsfield	0	0	0	1	1	2
Becket	0	0	0	1	0	1
Total	8	6	46	486	169	715

CASES FOR SEPTEMBER BY DAYS

September	3	4	5	6	7	Total
Cases	26	35	46	22	40	169

Three cases reported during August have been revoked, one from Cambridge, one from Fall River and one from Malden.

CASES BY WEEKS

Week Ending August 3	47
10	72
17	116
24	109
31	163
September 7	169

ORGANIZED MEDICINE GOES ON THE AIR

A copy of an announcement which will appear in *Hygeia* for October 1935 is appended.

This is evidence of the purpose of organized medicine to furnish practical instruction for use by the laity when confronted by emergencies of a medical nature. In order to promote the greatest possible interest in this movement, physicians may have, displayed in their offices, copies of this announcement. A few copies for distribution are in the office of the Boston Medical Library. State Medical Societies may bring this information to the public through announcements in the daily newspapers.

This plan is worthy of medical endorsement.

Dramatized Radio Programs for Medicine and Health!

"your health
ladies and gentlemen . . ."

This toast—through the music—each Tuesday at 5:00 P.M. Eastern Standard Time (4:00 P.M. Central Standard Time, 3:00 P.M. Mountain Time), will introduce the new radio program of the American Medical Association. It will be offered over the Blue network of the National Broadcasting Company, beginning October 1, 1935. With the coöperation of the National Broadcasting Company, a new type of program, in vivid dramatic form with incidental music, is being developed, showing

medical emergencies and how they are met!

The hero of the medical emergency, the doctor who is available day and night for the protection and promotion of YOUR HEALTH, is the real sponsor of this series of practical and entertaining health broadcasts.

Each Tuesday——
". . . ladies and gentlemen,
your health"

BLUE NETWORK, N. B. C.: WJZ—WSYR—KDKA—WCKY — WENR — WIBA — KSTP—WEBC KFYR — KWCR — WREN — KWK — KSO — WBAL — WMAL — WTAR — WPTF — WWNC WSOC — WIS — WSM — WMC — WJDX — KVOO — WKY — WFAA — KTBS — WOAI—

(Preprinted from *Hygeia*, the Health Magazine, October 1935.)

CORRESPONDENCE

AN EXTRAORDINARY MEDICAL RECORD

Editor, *New England Journal of Medicine*,

The following quotation is from *The Countryman*, a remarkable magazine published quarterly in London. It is full of the most unusual items, among them many concerning medical history, and I hope that physicians interested in unusual notes on the history of medicine and natural history may perhaps see it and derive as much pleasure from it as I have done. The quotation is from the current issue, July-September 1935.

"A Remarkable Inscription

"I have preached in the chapel at Loughborough, in the graveyard of which I copied the following inscription nearly forty years ago. I have also preached at the chapel at Wimeswold mentioned on the gravestone.

" 'In Memory of Sarah Johnson who died August 4th, 1819, aged 28.

" 'S. Johnson was tapped for Arcites 28 times, 6 operations by Dr. Vicars, 12 by Mr. Brown of Wimeswold.'

"Here follow in ruled columns the quantities in gallons, quarts and pints.

"Total in six years, 310 gallons, 1 quart, 1 pint."

Kenneth Bond.

Surely this seems an all-time record.

Very truly yours,

Wm. Pearce Coues, M.D.

Prouts Neck, Maine,
September 5, 1935.

ARTICLES ACCEPTED BY THE AMERICAN MEDICAL ASSOCIATION COUNCIL ON PHARMACY AND CHEMISTRY

535 North Dearborn Street, Chicago, Ill.,
September 5, 1935.

Managing Editor, *The New England Journal of Medicine*,

In addition to the articles enumerated in our letter of July 31 the following have been accepted:

Health Products Corporation
- White's Cod Liver Oil Concentrate (Liquid)
- White's Cod Liver Oil Concentrate Capsules, 3 minims
- White's Cod Liver Oil Concentrate (Liquid) Vials, 50 cc.

Hoffmann-LaRoche, Inc.
- Larocaine Hydrochloride

Lederle Laboratories, Inc.
- Cod Liver Oil Concentrate Liquid (Lederle)
- Cod Liver Oil Concentrate Liquid (Lederle) Vials, 5 cc.
- Cod Liver Oil Concentrate Liquid (Lederle) Capsules, 3 minims
- Diphtheria Antitoxin "Globulin—Lederle—Modified"
- Erysipelas Streptococcus Antitoxin "Globulin—Lederle—Modified"
- Tetanus Antitoxin "Globulin — Lederle — Modified"

Wm. S. Merrell Company
- Ampoules Solution Dextrose 50%, 20 cc.
- Ampoules Solution Dextrose 50%, 50 cc.

Parke, Davis & Co.
- Diphtheria Toxoid—P. D. & Co., one 0.5 cc. vial package
- Diphtheria Toxoid—P. D. & Co., one 5 cc. vial package
- Diphtheria Toxoid, Alum Precipitated—P. D. & Co., one 0.5 cc. vial package

Diphtheria Toxoid, Alum Precipitated—P. D. & Co., one 5 cc. vial package

E. R. Squibb & Sons
Iodobismitol with Saligenin (Squibb)

Yours sincerely,
PAUL NICHOLAS LEECH, *Secretary*,
Council on Pharmacy and Chemistry.

RECENT DEATH

NICHOLSON—MINNIE J. NICHOLSON, M.D., of 193 Main Street, Haverhill, Massachusetts, died in that city, August 31, 1935, at the Gale Hospital.

Dr. Nicholson was the widow of Dr. Samuel A. Nicholson, formerly of Haverhill, who died in 1914. She was born at Prince Edward Island, January 15, 1876. In 1915, she graduated from the College of Physicians and Surgeons in Boston and joined the Massachusetts Medical Society in 1920.

Dr. Nicholson is survived by a son, Dr. John Nicholson, of Waldoboro, Maine, and two grandchildren.

OBITUARY

RESOLUTIONS ADOPTED BY THE BOSTON CITY HOSPITAL IN APPRECIATION OF DOCTOR JOHN JOSEPH DOWLING

The Trustees of the Boston City Hospital wish to record their deep appreciation of the loss which the Hospital has suffered in the death of its Superintendent, Dr. John Joseph Dowling. For twenty years he lived with and for it; its interests were his interests. He watched it grow in size and reputation until it has become one of the great municipal hospitals of the world, and in this development he took an active part. He supervised its physical extension and was an essential factor in designing the new buildings and in rehabilitating the old, and the knowledge so obtained gave him a nation-wide reputation as an authority on hospital construction. The position of Superintendent of a large municipal hospital demands rare qualities of mind and heart. His earlier experiences as a family physician combined with a natural aptitude and a capacity for hard work gave him the training to cope with the conflicting interests which permeate such an institution and brought to him a measure of success impossible for lesser men. His devotion to the Hospital kept him at his post long after his failing health dictated his retirement, and he died as he had wished, in harness.

Generous, tactful, sane, a wise physician, an able administrator, a delightful companion, a sympathetic friend, Dr. Dowling has left on all those who came in contact with him a deep impression of his high character and honesty of purpose, and fragrant memories of their association with him.

The Trustees extend their heartfelt sympathy to his family, in whose grief they share.

(Signed) JOSEPH P. MANNING,
President, Board of Trustees.

Dr. John Joseph Dowling, Superintendent and Medical Director of the Boston City Hospital, died on July 10, 1935, of cerebral thrombosis, following an attack of pneumonia. He had suffered several serious breakdowns during the last year and recently had been granted leave of absence with the hope of recuperating his health. He is survived by his widow, Mrs. Marcia Pugh Dowling; a daughter, Miss Barbara Dowling, and a son, Mark Dowling. He was a Fellow of the Massachusetts Medical Society and the American Medical Association, and a member of the Harvard, City, and Clover Clubs.

Doctor Dowling was born in Boston in 1871, graduated from Boston Latin School in 1890 and from Harvard Medical School in 1894. After a year spent in study abroad he entered general practice in Roxbury and the South End of Boston.

In November 1914 he was appointed Acting Superintendent of the Boston City Hospital while Doctor McCollom was on leave of absence because of illness. In January 1915 Doctor McCollom retired and Doctor Dowling was appointed Superintendent. The hospital at that time was composed of a group of three-story buildings, most of which were very old. The equipment was obsolete and the wards were constantly crowded. After a year of intensive survey and study, Doctor Dowling began to lay plans for the enlargement of the hospital. In 1920 these plans began to materialize and eventually he reached his objective. To him, more than to anyone else, is given the major credit for the planning and completion of the present new buildings. He also brought to the hospital a group of skilled investigators, thus establishing the first research laboratory in any municipal hospital. In addition his advice was frequently sought by other hospital administrators who were contemplating new buildings and these contacts made him quite well known throughout the country as an able and experienced hospital executive.

One break occurred in the continuity of his service: when he went to war. In 1917 he organized and commanded Base Hospital No. 7, made up entirely of doctors, nurses, and employees of the hospital. The unit went to France in July of 1918 and was stationed at Tours, where it took over a plant of three thousand beds, handling many convoys of wounded troops. In a communication from Surgeon General Ireland, commending the unit, the following reference to Doctor Dowling was made: "I desire to invite attention to the excellent work done by Lieutenant Colonel John J. Dowling, M.C., as Director of Base Hospital No. 7, and further to express my sincere appreciation of the value of the services he gave to our country in its time of need."

Aside from his administrative qualities, he was best known as a gentle and sympathetic physician. Dignified yet approachable, he was ever ready to assist anyone whom he could. His advice was constantly sought and readily given. Twenty years' occupancy of a difficult and trying office never changed his calm and even temperament.

Our city is indebted to Doctor Dowling's vision for the present high standing of the hospital; and it will stand as a fitting monument to his memory.

P. F. BUTLER, M.D.,
Secretary, Senior Staff.

September sixth
Nineteen hundred and thirty-five.

NOTICES

INTERSTATE POSTGRADUATE MEDICAL ASSOCIATION OF NORTH AMERICA

The International Assembly of the Interstate Postgraduate Medical Association of North America will be held in the beautiful Masonic Temple, Detroit, Michigan, October 14, 15, 16, 17 and 18, 1935, with preassembly clinics on Saturday, October 12 and postassembly clinics Saturday, October 19, in the Detroit hospitals.

The Association through its officers and members of the program committee extends a very cordial invitation to all physicians in good standing in their State and Provincial Medical Societies to attend the Assembly. An unusual clinical and didactic program including all branches of medicine and surgery and the specialties has been arranged by the program committee.

In coöperation with the Wayne County Medical Society and the Michigan State Medical Society and with the active support of the Detroit Convention and Tourist Bureau and the Detroit Board of Commerce, a most excellent opportunity for an intensive week of postgraduate medical instruction is offered by a very large group of acknowledged leaders in the profession.

With a great deal of pride and satisfaction, we call your attention to the list of distinguished teachers and clinicians who will take part on the program which appears on page iii of the advertising section of this *Journal.*

Registration fee of $5.00 admits all members of the profession in good standing.

Programs may be secured by addressing Dr. Peck.

DR. CHARLES H. MAYO, *President,*
Rochester, Minn.,

DR. GEORGE CRILE, *Chairman,* Program Committee, Cleveland, Ohio,

DR. WILLIAM B. PECK, Managing-Director, Freeport, Ill.

INTERNATIONAL MEDICAL POSTGRADUATE COURSES IN BERLIN

COURSE OMITTED

The course in "The Biology of Heredity and Racial Purity in Medical Practice" planned by the Berliner Akademie für ärztliche Fortbildung from October 7-12 has been canceled.

TWO TOWNS WITHOUT PHYSICIANS

The Massachusetts towns of Newbury and Salisbury are without physicians.

OPENINGS FOR TWO DOCTORS

Two doctors who would be suitable additions to a Staff of Surgical Advisers are being sought. They should be relatively young, but not inexperienced, alert, graduates of good Medical Schools, and interested in making Industrial Surgery their life-work from an administrative viewpoint.

Any communication should be addressed to: R. N. Gray, M.D., Surgical Director, Ætna Life Insurance Company, Hartford, Connecticut.

ANNOUNCEMENTS

WINTHROP WETHERBEE, JR., M.D., announces the opening of an office at 482 Beacon Street, Boston. Telephone Kenmore 1806.

A. H. YUDELMAN, M.D., of 483 Beacon Street, has been given authority by the Probate Court to change his name to A. H. Delman.

NOTICE OF MEETING

NEW ENGLAND SURGICAL SOCIETY

The Annual Meeting of the New England Surgical Society will be held in Manchester, N. H., September 27 and 28, 1935. Headquarters: Hotel Carpenter.

GENERAL INFORMATION

Presentation of papers will be limited to fifteen minutes. Discussion to five minutes for each speaker. All manuscript should be presented to the Recorder promptly.

All papers will be published in The *New England Journal of Medicine,* the Official Organ of the Society.

NOTICE

Transportation will be provided to and from meeting places.

Golf may be played at any time at the Manchester Country Club.

GENERAL PROGRAM

FRIDAY, SEPTEMBER 27, 1935

8 A.M. to 10 A.M. Operative Clinic. Elliott Hospital.

10 A.M. to 12 Noon. Dry Clinic. Elliott Hospital.

12:30 P.M. Luncheon—Elliott Hospital.

2 P.M. Scientific Program. Ballroom — Hotel Carpenter.

5 P.M. Tea.

7 P.M. Annual Dinner. Manchester Country Club.

SATURDAY, SEPTEMBER 28, 1935

9 A.M. Annual Meeting of the Society. Ballroom—Hotel Carpenter.

9:30 A.M. to 12:30 P.M. Scientific Program. Ballroom—Hotel Carpenter.

SCIENTIFIC PROGRAM

Ballroom, Hotel Carpenter

FRIDAY AFTERNOON, SEPTEMBER 27, 1935

1. "Malignancy of the Breast." Dr. H. Gildersleeve Jarvis.
   Discussion: Dr. Channing Simmons, Dr. Robert B. Greenough.
2. "Results in Mammary Carcinoma at the Elliott Hospital." Dr. George C. Wilkins, Dr. George F. Dwinnell—by invitation.
   Discussion: Dr. Robert B. Greenough, Dr. Channing Simmons.
3. "Secondary Carcinomata of the Large Bowel." Dr. Edward L. Young, Jr.
   Discussion: Dr. Daniel F. Jones, Dr. Lucius C. Kingman.
4. "One Hundred Untreated Cancers of the Rectum." Dr. Ernest M. Daland, Dr. Claude Welch—by invitation, Dr. Ira Matheson—by invitation.
   Discussion: Dr. Lyman Allen, Dr. Walter C. Seelye.
5. "Stones in the Common and Hepatic Bile Duct." Dr. Frank H. Lahey.
   Discussion: Dr. Richard H. Miller, Dr. Ralph B. Ober.
6. "Inflammatory Sclerosis of the Bile Ducts." Dr. Horace K. Sowles.
   Discussion: Dr. Donald S. Adams, Dr. Carl M. Robinson.
7. "Surgical Complications of the Salmonella Supestifer." Dr. Irving Walker.
   Discussion: Dr. Samuel C. Harvey, Dr. John F. Gile.
8. "Congenital Diaphragmatic Hernia in Children." Dr. Philemon E. Truesdale.
   (To be read by title.)

SCIENTIFIC PROGRAM

Ballroom, Hotel Carpenter

SATURDAY MORNING, SEPTEMBER 28, 1935

1. "A Form of Sclerosing Osteomyelitis following Fractures of the Long Bones." Dr. Paul P. Swett.
   Discussion: Dr. James W. Sever, Dr. Robert B. Osgood.
2. "Statics of the Foot in Relation to Surgery." Dr. Frederic J. Cotton.
   Discussion: Dr. Carleton R. Metcalf, Dr. Ezra A. Jones.
3. "DeQuervain's Disease and Carpal Ganglia." Dr. Daniel C. Patterson.
   Discussion: Dr. George R. Anderson, Dr. James B. Woodman.
4. "Certain Aspects of Hand Surgery." Dr. Torr W. Harmer.
   Discussion: Dr. Edward H. Risley, Dr. Allen G. Rice.
5. "Congenital Absence of the Pericardium." Dr. William E. Ladd.
   Discussion: Dr. Thomas H. Lanman, Dr. David W. Parker.
6. "Urologic Aspects of Vesico-Vaginal Fistula." Dr. William C. Quinby.
   Discussion: Dr. Frank A. Pemberton, Dr. Stephen Rushmore.
7. "Acute Arterial Obstruction with Arteritis." Dr. Howard M. Clute.
   Discussion: Dr. Arthur W. Allen, Dr. John Homans.
8. "Personal Experiences with Cancer of the Bladder." Dr. J. Dellinger Barney.
   (To be read by title.)
9. "Reconstruction of the Vagina from a Portion of the Sigmoid; Report of a Case." Dr. Herman C. Pitts.
   (To be read by title.)

SOCIETY MEETINGS, CONGRESSES AND CONFERENCES

CALENDAR OF BOSTON DISTRICT FOR THE WEEK BEGINNING MONDAY, SEPTEMBER 16, 1935

Wednesday, September 18—

†12 M. Clinico-Pathological Conference. Children's Hospital.

Saturday, September 21—

*10-12. Staff rounds at the Peter Bent Brigham Hospital.

*Open to the medical profession.
†Open to Fellows of the Massachusetts Medical Society.

September 17, 18, 19—Eleventh Clinical Congress of the Connecticut State Medical Society. For details address Dr. Creighton Barker, 129 Whitney Avenue, New Haven, Conn.

September 27-28—New England Surgical Society. See page 549.

September 30-October 12—International Medical Post-Graduate Courses in Berlin. For further information apply to the Geschäftsstelle der Berliner Akademie für ärtzliche Fortbildung, Robert Koch—Platz 7 (Kaiserin Friedrich-Haus), Berlin N. W. 7.

October 6-20—Seventh Annual Training Course For Medical Reservists at the Mayo Clinic. See page 441, issue of August 29.

October 7-10—American Public Health Association will meet in Milwaukee, Wisconsin. For information address the American Public Health Association, 50 West 50th Street, New York City.

October 14-19—Inter-State Postgraduate Medical Association of North America. See page 549.

October 21 - November 2—1935 Graduate Fortnight of the New York Academy of Medicine. See page 898, issue of May 9.

October 28 - November 1—The Twenty-Fifth Clinical Congress of the American College of Surgeons. See page 1065, issue of May 30.